Cambridge Assessment International Education

Example Candidate Responses
Paper 4

Cambridge IGCSE™
Combined Science 0653

Cambridge O Level
Combined Science 5129

For examination from 2019

Version 1

Cambridge Pathway

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Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge IGCSE Combined Science 0653 and Cambridge O Level Combined Science 5129, and to show how different levels of candidates' performance (high, middle and low) relate to the subject's curriculum and assessment objectives.

In this booklet candidate responses have been chosen from June 2019 scripts to exemplify a range of answers.

For each question, the response is annotated with a clear explanation of where and why marks were awarded or omitted. This is followed by examiner comments on how the answer could have been improved. In this way, it is possible for you to understand what candidates have done to gain their marks and what they could do to improve their answers. There is also a list of common mistakes candidates made in their answers for each question.

This document provides illustrative examples of candidate work with examiner commentary. These help teachers to assess the standard required to achieve marks beyond the guidance of the mark scheme. Therefore, in some circumstances, such as where exact answers are required, there will not be much comment.

The questions and mark schemes and pre-release material used here are available to download from the School Support Hub. These files are:

June 2019 Question Paper 41

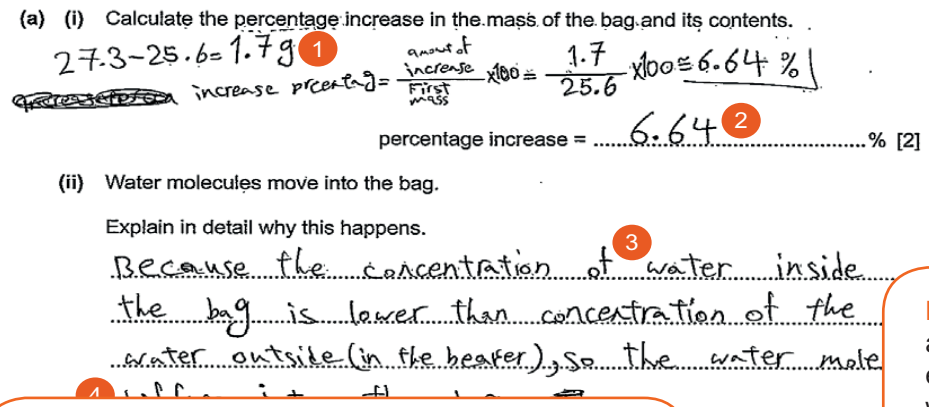
June 2019 Paper 41 Mark Scheme

Past exam resources and other teacher support materials are available on the School Support Hub:

www.cambridgeinternational.org/support

How to use this booklet

This booklet goes through the paper one question at a time, showing you the high-, middle- and low-level response for each question. The candidate answers are set in a table. In the left-hand column are the candidate answers, and in the right-hand column are the examiner comments.

Example Candidate Response – Question 1, high	Examiner comments
	1 The first mark is awarded here for clearly showing the first step in the calculation. 2 The calculation is completed correctly and includes the correct number of significant figures. This calculation is set out very well and is awarded both marks.

Answers are by real candidates in exam conditions. These show you the types of answers for each level. Discuss and analyse the answers with your learners in the classroom to improve their skills.

Examiner comments are alongside the answers. These explain where and why marks were awarded. This helps you to interpret the standard of Cambridge exams so you can help your learners to refine their exam technique.

How the candidate could have improved their answer

- **(a)(ii)** The candidate was awarded both marks but it would have been better to have used the term *water potential* rather than *concentration of water*. The experiment concerned osmosis and the answer would have been improved if this word had been included.

This section explains how the candidate could have improved each answer. This helps you to interpret the standard of Cambridge exams and helps your learners to refine their exam technique.

Common mistakes candidates made in this question

- **(a)(i)** Candidates often correctly calculated the increase in mass of the bag plus contents to be 1.7g. The method for expressing 1.7g as a percentage of 25.6g, was unfamiliar to many candidates and a variety of incorrect attempts to do this were suggested.

Often candidates were not awarded marks because they misread or misinterpreted the questions.

Lists the common mistakes candidates made in answering each question. This will help your learners to avoid these mistakes and give them the best chance of achieving the available marks.

Question 1

Example Candidate Response – high

1 Fig. 1.1 shows a bag containing sucrose solution placed in a beaker of water for 20 minutes.

The bag acts like the partially permeable membranes in cells. It allows small molecules to pass through. It does not allow larger molecules such as sucrose to pass through.

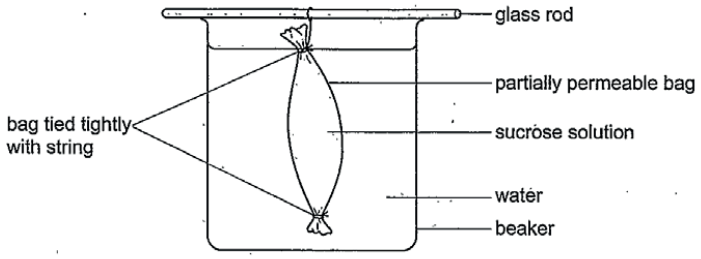


Fig. 1.1

The mass of the bag and its contents shown in Fig. 1.1 increases from 25.6 g to 27.3 g.

(a) (i) Calculate the percentage increase in the mass of the bag and its contents.

27.3 − 25.6 = 1.7 g 1

increase percentage = $\frac{\text{amount of increase}}{\text{First mass}} \times 100 = \frac{1.7}{25.6} \times 100 = 6.64\ \%$

percentage increase = 6.64 2 % [2]

(ii) Water molecules move into the bag.

Explain in detail why this happens.

Because the concentration of 3 water inside the bag is lower than concentration of the water outside (in the beaker), so the water molecules 4 diffuse into the bag. [2]

(b) Suggest **one** molecule from the list which is unable to pass through the partially permeable bag.

carbon dioxide glucose oxygen nitrogen protein

Glucose. 5 [1]

Examiner Comments

1 The first mark is awarded here for clearly showing the first step in the calculation.

2 The calculation is completed correctly and includes the correct number of significant figures.

This calculation is set out very well and is awarded both marks.

Mark for (a)(i) = 2 out of 2

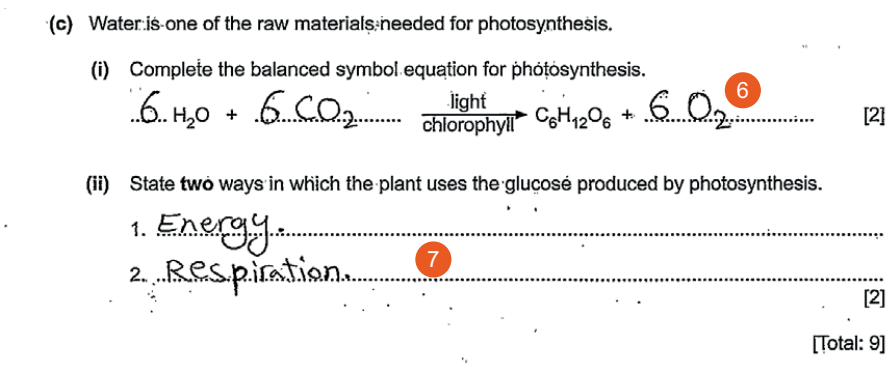
3 It is made clear that the candidate is referring to the concentration of water and not sucrose. The relative concentrations of water outside and inside the partially permeable bag are correct.

4 Correct use of the term 'diffuse' so both marks are awarded for (a)(ii).

Mark for (a)(ii) = 2 out of 2

5 The correct answer is protein.

Mark for (b) = 0 out of 1

Example Candidate Response – high, continued	Examiner Comments
	6 The chemical formulae are all correct and the equation is correctly balanced. The chemical formulae are very well presented with appropriate sizes for the numbers used for subscripts and balancing. Mark for (c)(i) = 2 out of 2 7 One mark is awarded for respiration. The answer energy is vague. Appropriate wording is *to provide energy* but this is not significantly different from respiration so only one mark can be awarded. Mark for (c)(ii) = 1 out of 2 **Total mark awarded = 7 out of 9**

How the candidate could have improved their answer

- **(a)(ii)** The candidate was awarded both marks but it would have been better to have used the term *water potential* rather than *concentration of water*. The experiment concerned osmosis and the answer would have been improved if this word had been included.
- **(b)** The candidate should have selected protein.
- **(c)(ii)** The answer *energy* was vague. The phrase *to provide or release energy* would have been better. Respiration provided energy and so the two answers given were equivalent. A second mark would have been awarded if they had described the conversion of glucose into starch.

Example Candidate Response – middle

1 Fig. 1.1 shows a bag containing sucrose solution placed in a beaker of water for 20 minutes.

The bag acts like the partially permeable membranes in cells. It allows small molecules to pass through. It does not allow larger molecules such as sucrose to pass through.

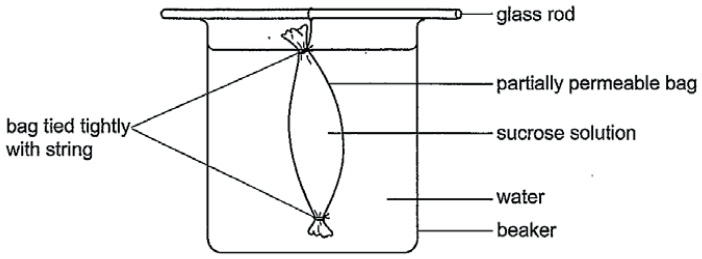


Fig. 1.1

The mass of the bag and its contents shown in Fig. 1.1 increases from 25.6 g to 27.3 g.

(a) (i) Calculate the percentage increase in the mass of the bag and its contents.

$\frac{25.6g}{100} \times 27.3g =$ 1

percentage increase = 6.99 % [2]

(ii) Water molecules move into the bag.

Explain in detail why this happens.

The water moves from an area of high water concentration to an area of low concentration by osmosis. It balances the concentrations. 2

[2]

(b) Suggest **one** molecule from the list which is unable to pass through the partially permeable bag.

carbon dioxide **glucose** **oxygen** **nitrogen** **protein**

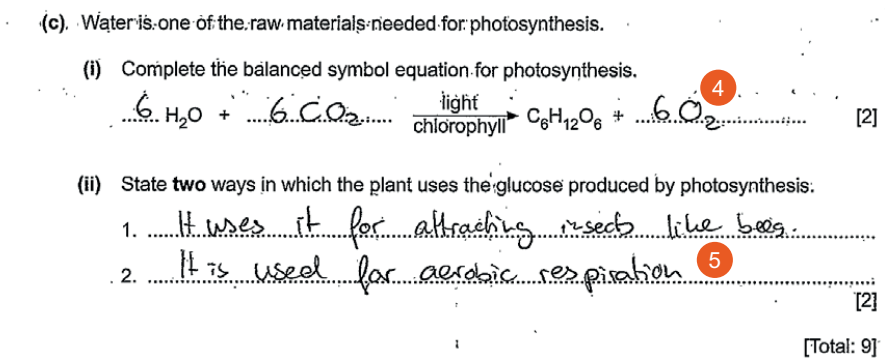
glucose 3 [1]

Examiner Comments

1 The calculation is incorrect.
Mark for (a)(i) = 0 out of 2

2 The candidate clearly refers to the concentration of water rather than sucrose. It is assumed that the second reference to concentration also refers to water. The word osmosis is used and the direction of water movement is correctly described. Both marks are awarded.
Mark for (a)(ii) = 2 out of 2

3 This is an incorrect answer.
Mark for (b) = 0 out of 1

Example Candidate Response – middle, continued	Examiner Comments
	4 The chemical formulae are all correct and the equation is correctly balanced. The chemical formulae are very well presented with appropriate sizes for the numbers used for subscripts and balancing. Mark for (c)(i) = 2 out of 2 5 One mark is awarded for the reference to respiration. Mark for (c)(ii) = 1 out of 2 **Total mark awarded = 5 out of 9**

How the candidate could have improved their answer

- **(a)(i)** The candidate could have been awarded at least one mark if they had calculated the increase in mass of the bag plus contents.
- **(b)** The candidate should have selected protein.
- **(c)(ii)** The candidate was awarded one mark for referring to respiration and would have been awarded the second mark if they had referred to the conversion of glucose into starch.

Example Candidate Response – low

1 Fig. 1.1 shows a bag containing sucrose solution placed in a beaker of water for 20 minutes.

The bag acts like the partially permeable membranes in cells. It allows small molecules to pass through. It does not allow larger molecules such as sucrose to pass through.

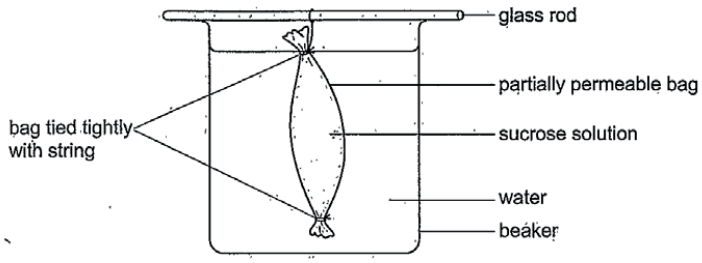


Fig. 1.1

The mass of the bag and its contents shown in Fig. 1.1 increases from 25.6 g to 27.3 g.

(a) (i) Calculate the percentage increase in the mass of the bag and its contents.

27.3 - 25.6

1

percentage increase = 1.7 % [2]

(ii) Water molecules move into the bag.

Explain in detail why this happens.

Because the water molecules are small enough to diffuse through the partially permeable membrane. 2

[2]

(b) Suggest **one** molecule from the list which is unable to pass through the partially permeable bag.

carbon dioxide **glucose** **oxygen** **nitrogen** **protein**

3 nitrogen [1]

Examiner Comments

1 The candidate has calculated the increase in mass of the bag plus contents. Although the result has been shown as the percentage increase the first point in the mark scheme is awarded.

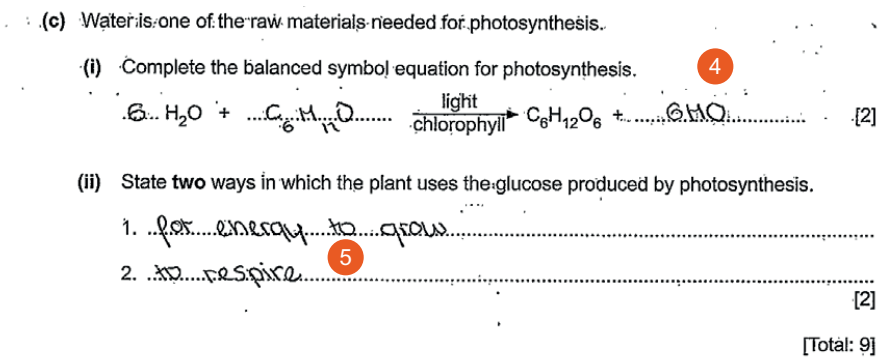
Mark for (a)(i) = 1 out of 2

2 One mark is awarded for the correct use of the word diffuse.

Mark for (a)(ii) = 1 out of 2

3 This is an incorrect answer.

Mark for (b) = 0 out of 1

Example Candidate Response – low, continued	Examiner Comments
 (c) Water is one of the raw materials needed for photosynthesis. (i) Complete the balanced symbol equation for photosynthesis. 4 6 H_2O + $C_6H_{12}O_6$ $\xrightarrow[\text{chlorophyll}]{\text{light}}$ $C_6H_{12}O_6$ + 6 HO [2] (ii) State **two** ways in which the plant uses the glucose produced by photosynthesis. 1. for energy to grow 2. to respire 5 [2] [Total: 9]	4 The candidate has suggested incorrect chemical formulae. No marks are awarded. Mark for (c)(i) = 0 out of 2 5 Respiration provides energy and so the answers are not significantly different. One mark is awarded. Mark for (c)(ii) = 1 out of 2 **Total mark awarded = 3 out of 9**

How the candidate could have improved their answer

- **(a)(i)** The candidate had started this calculation correctly but they needed to go on to express the increase in mass of the bag plus contents as a percentage of the initial mass.
- **(a)(ii)** The candidate's answer was a valid scientific description of processes occurring in this question and one mark was awarded for the correct use of the term *diffuse*. The question asked for an explanation of why water molecules tend to move **into** the bag. The candidate would have been awarded the second mark for referring to the difference in water concentration, or better, water potential that drives the direction of movement of molecules.
- **(c)(ii)** Respiration provided energy and so the two answers given were equivalent. A second mark would have been awarded for a description of the conversion of glucose into starch.

Common mistakes candidates made in this question

- In **(a)(i)**, candidates often correctly calculated the increase in mass of the bag plus contents to be 1.7g. The method for expressing 1.7g as a percentage of 25.6g, was unfamiliar to many candidates and a variety of incorrect attempts to do this were suggested.
- In **(a)(ii)**, many candidates did not explain the direction of movement of water molecules **into** the bag. Answers such as *molecules are very small and can pass through the holes in the membrane* were frequently suggested. This explained why water molecules were able to pass through the membrane but candidates needed to explain why the molecules moved in the direction that they did.
- In **(b)**, glucose was often suggested but candidates should have known that glucose diffuses through partially-permeable membranes in the body.
- In **(c)(i)**, some candidates wrote the names of substances rather than giving chemical formulae. Some others reversed the positions of oxygen, O_2, and carbon dioxide, CO_2. Partial credit was not awarded for an equation that was balanced but which contained incorrect chemical formulae.
- In **(c)(ii)**, candidates often suggested *respiration* and *for energy* as their two uses of glucose. These answers were equivalent and so only one mark could be awarded. Two other common mistakes were *for food* and *for growth and repair of cells*.

Question 2

Example Candidate Response – high	Examiner Comments

2 When large hydrocarbon molecules are cracked, they break down into smaller hydrocarbon molecules.

Fig. 2.1 shows the structures of five hydrocarbon molecules **A** to **E** which are produced when the alkane, $C_{10}H_{22}$, is cracked.

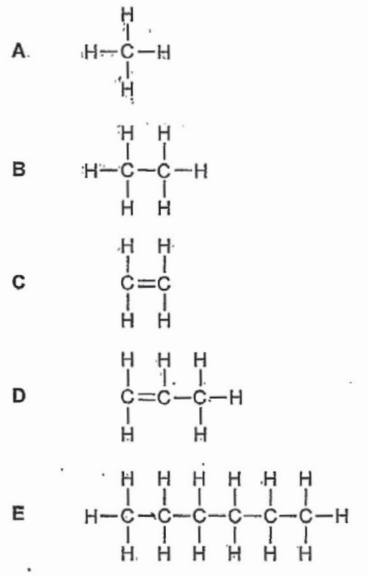


Fig. 2.1

(a) State **one** condition used for cracking hydrocarbons.

heat 1 ..... [1]

(b) State **all** the molecules from **A** to **E** that:

(i) are saturated

A B E ..... [1]

(ii) are alkanes

A B E 2 ..... [1]

(iii) produce carbon dioxide and water on complete combustion in oxygen.

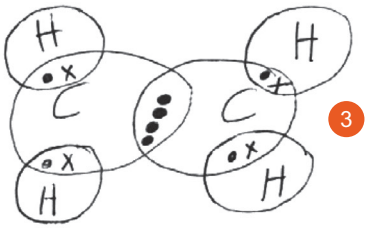
A B E C D ..... [1]

1 The term heat is accepted as an alternative to high temperature which appears in the mark scheme.

Mark for (a) = 1 out of 1

2 All parts of question **(b)** are correctly completed with no omissions or additions.

Mark for (b)(i) = 1 out of 1
Mark for (b)(ii) = 1 out of 1
Mark for (b)(iii) = 1 out of 1

Example Candidate Response – high, continued	Examiner Comments
(c) Draw a dot-and-cross diagram to show the bonding in molecule **C**.  3 [2]	3 The dot-and-cross diagram is clear and correct. Bonding electron pairs and chemical symbols are shown correctly. Mark for (c) = 2 out of 2
(d) Molecules **C** and **D** are members of the same homologous series. Explain what is meant by the term *homologous series*. series that have the same general formula and consist of the same elements. 4 [2] [Total: 8]	4 The reference to a general formula is awarded one mark. The idea that the same elements are contained is not precise enough to define an homologous series. Mark for (d) = 1 out of 2 **Total mark awarded = 7 out of 8**

How the candidate could have improved their answer

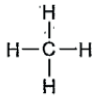
- **(a)** Although *heat* was accepted, the answer *high temperature* was much better.
- **(d)** It would have been better if this answer had started with the phrase *A family of compounds that…* rather than repeating the word *series*. The candidate should have described how members of an homologous series showed similar chemical properties.

Example Candidate Response – middle	Examiner Comments

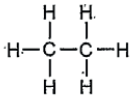
2 When large hydrocarbon molecules are cracked, they break down into smaller hydrocarbon molecules.

Fig. 2.1 shows the structures of five hydrocarbon molecules **A** to **E** which are produced when the alkane, $C_{10}H_{22}$, is cracked.

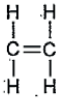
A



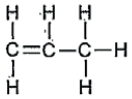
B



C



D



E

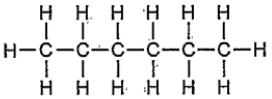


Fig. 2.1

(a) State **one** condition used for cracking hydrocarbons.

1 catalyst must be present ..... [1]

(b) State **all** the molecules from **A** to **E** that:

(i) are saturated

2 A, B, E ..... [1]

(ii) are alkanes

3 C, D ..... [1]

(iii) produce carbon dioxide and water on complete combustion in oxygen.

4 A, B, C, D, E ..... [1]

1 A correct reference to the need for a catalyst is made and one mark is awarded.

Mark for (a) = 1 out of 1

2 Part **(i)** contains no omissions or additions and so one mark is awarded.

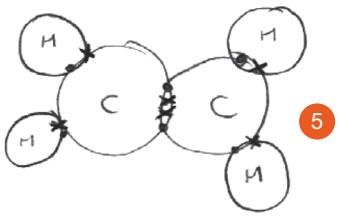
Mark for (b)(i) = 1 out of 1

3 The candidate has identified the alkenes and not the alkanes and so no mark is awarded.

Mark for (b)(ii) = 0 out of 1

4 Part **(iii)** contains no omissions or additions and so one mark is awarded.

Mark for (b)(iii) = 1 out of 1

Example Candidate Response – middle, continued	Examiner Comments
(c) Draw a dot-and-cross diagram to show the bonding in molecule **C**.  5 [2] **(d)** Molecules **C** and **D** are members of the same homologous series. Explain what is meant by the term *homologous series*. molecules that have similar properties and are made from the same elements 6 [2] [Total: 8]	5 This dot-and-cross diagram is acceptable. The bonding electron pairs and the chemical symbols are shown. Mark for (c) = 2 out of 2 6 It is essential that the answer refers to chemical properties rather than simply to properties. The idea that the same elements are involved is not precise enough to define a homologous series. Mark for (d) = 0 out of 2 **Total mark awarded = 5 out of 8**

How the candidate could have improved their answer

- **(b)(ii)** The candidate needed to select the alkanes, **A**, **B** and **E**, rather than the alkenes, **C** and **D**.
- **(c)** Although both marks were awarded, it would have been better if the candidate's diagram had been larger. This would have allowed the positions of the bonding electrons in all of the C-H bonds to have been shown more clearly.
- **(d)** It would have been better if this answer had started with the phrase *A family of compounds that…* rather than the word *molecules*. The candidate should have described how members of an homologous series showed similar **chemical** properties and were described by a general chemical formula.

Example Candidate Response – low	Examiner Comments

2 When large hydrocarbon molecules are cracked, they break down into smaller hydrocarbon molecules.

Fig. 2.1 shows the structures of five hydrocarbon molecules **A** to **E** which are produced when the alkane, $C_{10}H_{22}$, is cracked.

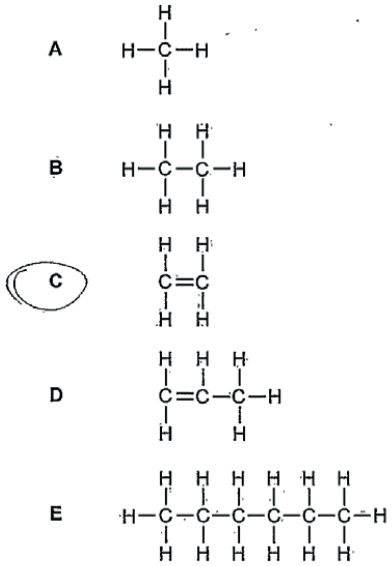


Fig. 2.1

(a) State **one** condition used for cracking hydrocarbons.

~~heated test tube~~ heat 1 [1]

(b) State **all** the molecules from **A** to **E** that:

(i) are saturated

~~A,B,E~~ C,D 2 [1]

(ii) are alkanes

A,B,E 3 [1]

(iii) produce carbon dioxide and water on complete combustion in oxygen.

C,D 4 [1]

1 The term heat is accepted as an alternative to high temperature which appears in the mark scheme.

Mark for (a) = 1 out of 1

2 The correct answer has been crossed out. No mark is awarded.

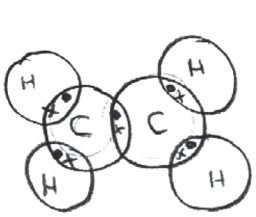
Mark for (b)(i) = 0 out of 1

3 The answer is correct.

Mark for (b)(ii) = 1 out of 1

4 The question asks for **all** of the compounds in the list that produce carbon dioxide and water when combusted. All five compounds must be listed before the mark is awarded.

Mark for (b)(iii) = 0 out of 1

Example Candidate Response – low, continued	Examiner Comments
(c) Draw a dot-and-cross diagram to show the bonding in molecule **C**.  hydrogen = 1 carbon = 6 5 [2] **(d)** Molecules **C** and **D** are members of the same homologous series. Explain what is meant by the term *homologous series*. The homologous series is when the molecule contain similar properties, C and D both have double bonds. 6 [2] [Total: 8]	5 The diagram shows only one bonding pair of electrons between the carbon atoms and so the first mark on the scheme has not been awarded. The second point, all else correct, is not dependent on the first and one mark is awarded. Mark for (c) = 1 out of 2 6 This answer shows some familiarity with the idea of an homologous series but is not precise enough. The answer should specify similar chemical properties and refer to a general chemical formula for members of the series. Mark for (d) = 0 out of 2 **Total mark awarded = 3 out of 8**

How the candidate could have improved their answer

- **(a)** Although *heat* was accepted, the answer *high temperature* was much better.
- **(b)(i)** The candidate needed to select the alkanes, **A**, **B** and **E**, rather than the alkenes, **C** and **D**.
- **(b)(iii)** All of the hydrocarbons in the list should have been selected.
- **(c)** The dot-and cross diagram should have shown two pairs of electrons between the carbon atoms.
- **(d)** This answer would have been improved by describing *a family of compounds* rather than *the molecule*. The family of compounds could then have been qualified by stating that each member of the family (series) was described by a general chemical formula and showed similar chemical properties. The idea of similar properties was not precise enough.

Common mistakes candidates made in this question

- **(a)(i)** The one-word answer *temperature* was frequently suggested. Other answers that lacked precision were *warm temperature* and a *suitable temperature*. Candidates had to specify *high temperature*. Answers that did not describe reaction conditions were also suggested and these mainly included the names of substances, for example, *hydrocarbons*, *large hydrocarbons*, *alkanes* and *oxygen*.
- **(b)(i)** The most common mistake was to suggest **C** and **D**, the unsaturated rather than the saturated hydrocarbons.
- The most common mistake in **(b)(ii)** was similar to that in **(b)(i)** with candidates suggesting **C** and **D**.
- **(b)(iii)** The common mistake was the omission of one or more of the five compounds in the list.
- **(c)** One common mistake was to draw a structural formula rather than a dot-and-cross diagram. Mistakes involving electrons were to draw only two bonding electrons between the carbon atoms and to include additional electrons in the outer shells of the carbon and/or hydrogen atoms.
- **(d)** Candidates frequently described particular homologous series, either the alkanes or the alkenes, rather than giving general characteristics of any homologous series. The idea that homologous series simply contained the same elements was often suggested. Many candidates referred to *similar properties*, but they needed to specify *similar chemical properties*.

Question 3

Example Candidate Response – high	Examiner Comments

3 Fig. 3.1 shows a whale swimming underwater.

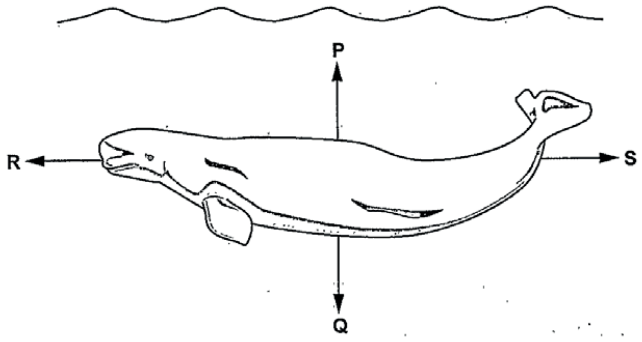


Fig. 3.1

(a) The force arrows labelled **P** and **Q** show the vertical forces acting on the whale.

Force **Q** has a value of 14 000 N. The whale is swimming at constant depth.

(i) State the value of force **P**.

force **P** = 14 000 N [1]

1

1 This is the correct answer.

Mark for (a)(i) = 1 out of 1

(ii) The gravitational field strength *g* is 10 N/kg.

Calculate the mass of the whale.

$W = m \times g$

$m = W/g$

mass = 1400 kg [1]

2

2 This is a good answer. It shows the correct value of the mass and how this is calculated.

Mark for (a)(ii) = 1 out of 1

(b) The whale pushes itself forward with a force of 500 N at a constant speed of 5.4 km/h. It travels a distance of 2.0 km.

(i) Determine the speed of the whale in m/s.

Show your working.

$s = d/t$

$s = 5.4\ km/h$

$s = 5400\ m/h$

$s = 1.5\ m/s$

speed = 1.5 m/s [2]

3

3 This answer is awarded both marks because the candidate has stated the numerical answer correctly and enough working is shown.

Mark for (b)(i) = 2 out of 2

Example Candidate Response – high, continued

(ii) Calculate the work done by the whale on this journey.

Show your working.

work done = force × distance 4

= 500 × 2.0

= 1000

work done = 1000 J [2]

(iii) Use your answers to **(a)(ii)** and **(b)(i)** to calculate the kinetic energy of the whale.

Show your working.

$KE = \frac{1}{2} \times m \times v^2$

$= \frac{1}{2} \times 1400 \times 1.5^2$ 5

$= 1575 J$

kinetic energy = 1575 J [2]

(c) The whale communicates with other whales by emitting high-pitched sounds.

(i) Explain why whales in the sea can hear each other over great distances with less time delay than if the sound travelled through air.

high-pitched sounds travel at a faster speed than low-pitched sounds that we can hear 6 [1]

(ii) Beluga whales produce sound frequencies in the range 4 kHz to 150 kHz.

Human voices produce frequencies at the lower end of the range of human hearing.

A diver claims that Beluga whales can imitate the human voice.

Use your knowledge of human hearing to suggest how well Beluga whales can imitate the human voice. Explain your answer.

7 the human hearing range is between 20 and 20000 Hz. the lowest a Beluga whale can hear and imitate is 4000 Hz. So a Beluga whale would find it difficult to imitate a humans voice at the lower end of our hearing range. [2]

[Total: 11]

Examiner Comments

4 One mark is awarded for showing how work is calculated from the force and the distance. The value of the distance used in the calculation is incorrect because the units are incorrect.

Mark for (b)(ii) = 1 out of 2

5 The correct relationship between kinetic energy, mass and velocity is shown and values are correctly substituted to produce the final answer.

Mark for (b)(iii) = 2 out of 2

6 This answer is incorrect.

Mark for (c)(i) = 0 out of 1

7 One mark is awarded for correctly stating the range of human hearing. The reference to the whale's hearing is ignored because the remaining ideas in this answer can be interpreted as the whale sounding high-pitched to humans, which is the final point stated in the mark scheme. This is a good answer and both marks are awarded.

Mark for (c)(ii) = 2 out of 2

Total mark awarded = 9 out of 11

How the candidate could have improved their answer

- **(b)(i)** Although this was a good answer, an improvement would have been to state that the number of seconds in 1 hour was 3600 and that this was divided into 5400 m/hr to arrive at the final answer.
- **(b)(ii)** The candidate needed to convert the units of distance from kilometres to metres before calculating the work done.
- **(c)(i)** The candidate had referred to the relative speed of sound but incorrectly. They needed to describe the difference in speed that occurred through liquids and gases.
- **(c)(II)** A small improvement to this good answer would have been to avoid any reference to the hearing range of the whale.

Example Candidate Response – middle

3 Fig. 3.1 shows a whale swimming underwater.

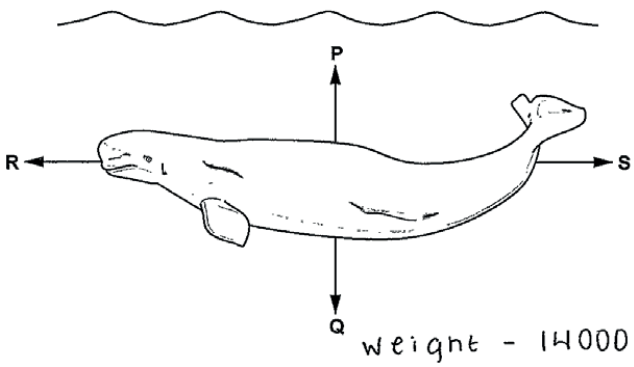


Fig. 3.1

(a) The force arrows labelled **P** and **Q** show the vertical forces acting on the whale.

Force **Q** has a value of 14000 N. The whale is swimming at constant depth.

(i) State the value of force **P**.

force **P** = 14,000 (1) N [1]

(ii) The gravitational field strength *g* is 10 N/kg.

Calculate the mass of the whale.

$m = \frac{W}{g}$ $\frac{14,000}{10}$

mass = 1400 (2) kg [1]

(b) The whale pushes itself forward with a force of 500 N at a constant speed of 5.4 km/h. It travels a distance of 2.0 km.

(i) Determine the speed of the whale in m/s.

Show your working.

5.4 x 60 x 60 (3)

speed = 19440 m/s [2]

Examiner Comments

1 This is the correct answer.

Mark for (a)(i) = 1 out of 1

2 The value of mass is correctly calculated. This is a good answer because working is shown.

Mark for (a)(ii) = 1 out of 1

3 The working is incorrect. The error is not carried forward and so no mark is awarded.

Mark for (b)(i) = 0 out of 2

Example Candidate Response – middle, continued

(ii) Calculate the work done by the whale on this journey.

Show your working.

force × distance

500 × 2.0 =

work done = 1000 J [2]

4

(iii) Use your answers to **(a)(ii)** and **(b)(i)** to calculate the kinetic energy of the whale.

Show your working.

$\frac{1}{2}$ × mass × velocity^2

$\frac{1}{2}$ × 1400 × 19440^2

5

kinetic energy = 2.64539 52 x 10^{11} J [2]

(c) The whale communicates with other whales by emitting high-pitched sounds.

(i) Explain why whales in the sea can hear each other over great distances with less time delay than if the sound travelled through air.

sound can travel through a medium.

6

[1]

(ii) Beluga whales produce sound frequencies in the range 4 kHz to 150 kHz.

Human voices produce frequencies at the lower end of the range of human hearing.

A diver claims that Beluga whales can imitate the human voice.

Use your knowledge of human hearing to suggest how well Beluga whales can imitate the human voice. Explain your answer.

The human hearing range is 20Hz to 20,000 Hz. If the whales can hear from 4000 Hz and they can imitate the human ~~voice~~ voice. [2]

7

[Total: 11]

Examiner Comments

4 One mark is awarded for showing how work is calculated from the force and the distance. The value of the distance used in the calculation is incorrect because the units are incorrect.

Mark for (b)(ii) = 1 out of 2

5 One mark is awarded for the expression used to calculate kinetic energy. The second mark is also awarded because the error in velocity from part (b)(i) is carried forward and the kinetic energy expression is evaluated correctly. The inappropriate number of decimal places is ignored in this case.

Mark for (b)(iii) = 2 out of 2

6 This answer is scientifically correct but makes an irrelevant point, so no mark is awarded.

Mark for (c)(i) = 0 out of 1

7 One mark is awarded for correctly stating the range of human hearing.

Mark for (c)(ii) = 1 out of 2

Total mark awarded = 6 out of 11

How the candidate could have improved their answer

- **(b)(i)** The candidate would have been awarded one mark if they had divided 5.4 by 60 × 60. If they had done this, then an error carried forward could have been applied.
- **(b)(ii)** The candidate needed to convert the units of distance from kilometres to metres before calculating the work done.
- **(b)(iii)** This answer would have been improved if the final answer had been rounded to the appropriate number of significant figures.
- **(c)(i)** The candidate had made a scientifically correct point but it did not answer the question. The answer should have related the difference in the speed of sound through liquids and gases.
- **(c)(II)** The candidate had made an attempt to relate the range of human hearing to frequencies associated with the whale. However, they should have referred to sound emitted by, rather than sound heard by, the whale.

Example Candidate Response – low	Examiner Comments

3 Fig. 3.1 shows a whale swimming underwater.

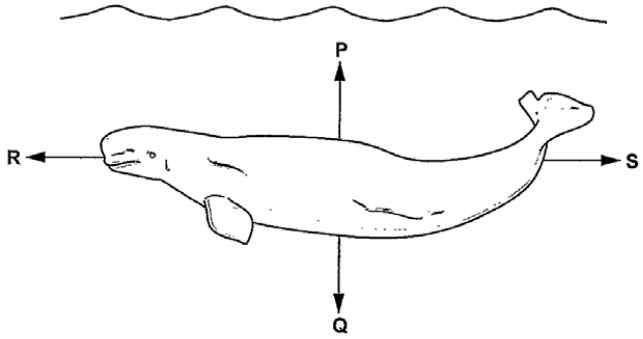


Fig. 3.1

(a) The force arrows labelled **P** and **Q** show the vertical forces acting on the whale.

Force **Q** has a value of 14 000 N. The whale is swimming at constant depth.

(i) State the value of force **P**.

force **P** = upthrust N [1]

1

(ii) The gravitational field strength *g* is 10 N/kg.

Calculate the mass of the whale.

mass = volume x density
14000N x 10N/kg = 140000kg

mass = 140000 kg [1]

2

(b) The whale pushes itself forward with a force of 500 N at a constant speed of 5.4 km/h. It travels a distance of 2.0 km.

(i) Determine the speed of the whale in m/s.

Show your working.

~~speed = distance x time~~

speed = distance / time

distance = 2.0 km
time = 5.4 km/h

2000 / 5400 = 0.370

speed = 0.370 m/s [2]

3

1 Force **P** is the upthrust but the numerical value is required. No mark is awarded.

Mark for (a)(i) = 0 out of 1

2 The numerical value of mass is incorrect and the working shown does not correspond to any of the steps in the mark scheme. No mark is awarded.

Mark for (a)(ii) = 0 out of 1

3 One mark is awarded for stating the correct relationship between speed, distance and time. The other parts of this answer do not correspond to any of the other points in the mark scheme.

Mark for (b)(i) = 1 out of 2

Example Candidate Response – low, continued

(ii) Calculate the work done by the whale on this journey.

Show your working.

work done = force x distance
force = 500N
distance = 2.0km
500N x 2.0km = 1000

work done = 1000 4 J [2]

(iii) Use your answers to **(a)(ii)** and **(b)(i)** to calculate the kinetic energy of the whale.

Show your working.

kinetic energy = ½ mass x velocity²
½ x 0.370 x 1000²
mass ↑ velocity² ↑
5

kinetic energy = 185000 J [2]

(c) The whale communicates with other whales by emitting high-pitched sounds.

(i) Explain why whales in the sea can hear each other over great distances with less time delay than if the sound travelled through air.

because in the water sound waves are closer together 6 [1]

(ii) Beluga whales produce sound frequencies in the range 4 kHz to 150 kHz.

Human voices produce frequencies at the lower end of the range of human hearing.

A diver claims that Beluga whales can imitate the human voice.

Use your knowledge of human hearing to suggest how well Beluga whales can imitate the human voice. Explain your answer.

The human hearing range is 20Hz to 20,000 Hz., So beluga whales will not be able to imitate because if we produce frequancys at the lower end in 1,000 they would not be able to hear because the frequency of hearing is only 4Hz to 150Hz 7 [2]

[Total: 11]

Examiner Comments

4 One mark is awarded for showing how work is calculated from the force and the distance. The value of the distance used in the calculation is incorrect because the units are incorrect.

Mark for (b)(ii) = 1 out of 2

5 One mark is awarded for the correct equation for kinetic energy. Both of the substitutions into the equation are incorrect.

Mark for (b)(iii) = 1 out of 2

6 This answer is incorrect.

Mark for (c)(i) = 0 out of 1

7 One mark is awarded for the correct range of human hearing. The other parts of this answer refer to sounds heard by the whales rather than the frequencies that they emit.

Mark for (c)(ii) = 1 out of 2

Total mark awarded = 4 out of 11

How the candidate could have improved their answer

- **(a)(i)** The candidate should have given the numerical value rather than the name of the force.
- **(a)(ii)** The candidate needed to use the relationship between mass and weight rather than between mass and density.
- **(b)(i)** The candidate needed to realise that this question simply involved conversion of units and that the distance, 2.0km, was not involved.
- **(b)(ii)** The candidate should have converted the units of distance from kilometres to metres before calculating the work done.
- **(b)(iii)** Errors were carried forward in this calculation, and so, the candidate would have been awarded full credit if they had used the values for mass and velocity that they had stated in parts (a)(ii) and (b)(i).
- **(c)(i)** The candidate should have discussed the difference in the speed of sound in liquids and in gases.
- **(c)(II)** The candidate had made an attempt to compare the range of human hearing to frequencies associated with the whale but they should have referred to sound emitted by rather than sound heard by the whale.

Common mistakes candidates made in this question

- **(a)(i)** Some candidates named the force **P** as upthrust rather than deducing its numerical value.
- **(a)(ii)** The most common mistake was to multiply 14000N by 10 N/kg.
- **(b)(i)** It was clear that many candidates had not realised that all that was required was the conversion of units from km/h to m/s. A wide variety of attempts to complete unnecessarily complicated and incorrect calculations were suggested.
- **(b)(ii)** A common mistake was to use 2.0km rather than 2000m in the expression for work done.
- **(b)(iii)** Some candidates correctly substituted values for mass and velocity but did not square the velocity when they evaluated the kinetic energy. Other mistakes included omitting the term ½ or simply finding the product of mass x velocity.
- **(c)(i)** A common mistake was to miss the idea that the speed of sound was greater in a denser medium. Some answers made sense in scientific terms but were irrelevant, for example, *sound needs a medium to travel*. Others discussed ideas such as the presence of wind and obstacles that interfered with the passage of sound in air.
- **(c)(ii)** Some candidates made mistakes in the units of the range of human hearing, for example, 20kHz to 20000kHz. The information in the question was limited to the range of human hearing and the frequency range of sound emitted by the whales. Many candidates discussed comparisons of sound emitted by humans and the range of hearing of the whales.

Question 4

Example Candidate Response – high	Examiner Comments

4 Fig. 4.1 is a diagram of a sperm cell showing its adaptive features.

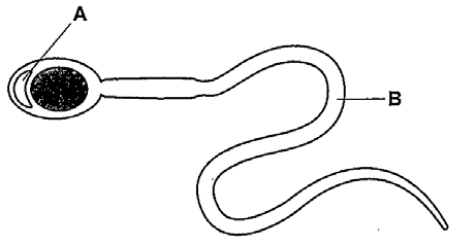


Fig. 4.1

(a) Name the adaptive features **A** and **B**.

A Acrosome; an enzyme that helps penetrate in the egg cell.

B Flagellum (tail), for mobility through the oviduct for example. [2]

(b) During fertilisation, the nucleus of the sperm cell fuses with the nucleus of an egg cell inside the female reproductive system.

(i) State where, inside the female reproductive system, fertilisation takes place.

Oviduct [1]

(ii) Explain why additional sperm cells cannot enter the egg after fertilisation.

Because egg cells have special cell membrane adapted for only one sperm to penetrate in. [1]

1 Both of the answers to (a) are of a very high standard. The term acrosome shows knowledge more advanced than required by the syllabus.

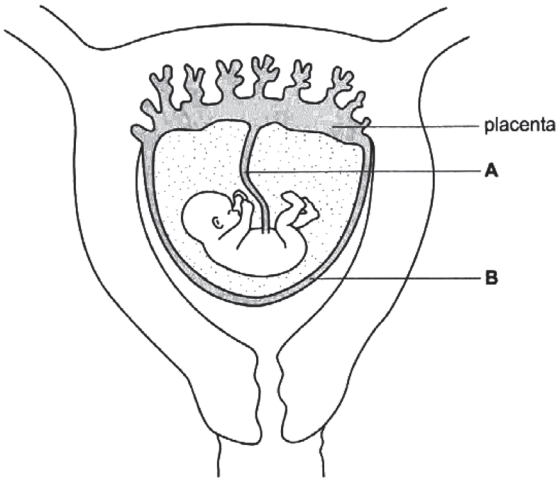
Mark for (a) = 2 out of 2

2 This is the correct answer.

Mark for (b)(i) = 1 out of 1

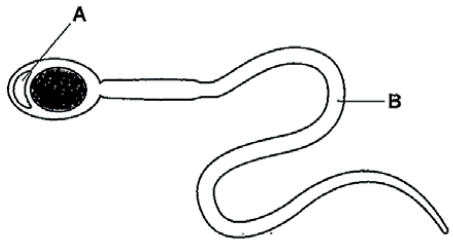
3 The idea that it is a feature of the egg that prevents a second sperm from entering is generally correct but the detail is incorrect. The candidate needs to explain that the jelly coating around the egg changes so other sperms cannot enter.

Mark for (b)(ii) = 0 out of 1

Example Candidate Response – high, continued	Examiner Comments
(c) Fig. 4.2 shows a diagram of a uterus containing a fetus.  **Fig. 4.2** **(i)** Name structures **A** and **B** shown in Fig. 4.2. **A** umbilical cord **B** amniotic bag 4 [2] **(ii)** The placenta is the organ where exchange of materials between mother and child occurs. Underline **two** words or phrases from the list to show substances that have a net movement **from mother to baby** through the placenta. **amino acids** **bone** **carbon dioxide** **cellulose** **glucose** **glycogen** **white blood cells** 5 [2] [Total: 8]	4 Both correct names are stated. The use of the word bag rather than sac is not penalised. Mark for (c)(i) = 2 out of 2 5 Only two words are underlined and both are correct. Mark for (c)(ii) = 2 out of 2 **Total mark awarded = 7 out of 8**

How the candidate could have improved their answer

- **(b)(ii)** The candidate should have explained that entry of the first sperm into the egg caused a change in the jelly coating surrounding the egg and that this prevented other sperms from entering.
- **(c)(i)** The answer would have been improved if the candidate had used the term amniotic sac rather than amniotic bag.

Example Candidate Response – middle	Examiner Comments
4 Fig. 4.1 is a diagram of a sperm cell showing its adaptive features.  **Fig. 4.1** **(a)** Name the adaptive features **A** and **B**. **A** To drill through the ovary to to fertilize. 1 **B** used to swim through fluid [2] **(b)** During fertilisation, the nucleus of the sperm cell fuses with the nucleus of an egg cell inside the female reproductive system. **(i)** State where, inside the female reproductive system, fertilisation takes place. inside the ovule in the phelopeon tube [1] **(ii)** Explain why additional sperm cells cannot enter the egg after fertilisation. The egg cell is covered in a sort of jelly that will harden once a sperm has fertilized [1]	1 No marks are awarded because the two features of the sperm cell are not named. No credit is available in this question for the functions of the features. Mark for (a) = 0 out of 2 2 Fallopian tube is an acceptable alternative to oviduct but no mark is awarded for this answer because of the incorrect reference to ovule. Mark for (b)(i) = 0 out of 1 3 This is a good answer and matches the mark scheme very closely. Mark for (b)(ii) = 1 out of 1

Example Candidate Response – middle, continued	Examiner Comments

(c) Fig. 4.2 shows a diagram of a uterus containing a fetus.

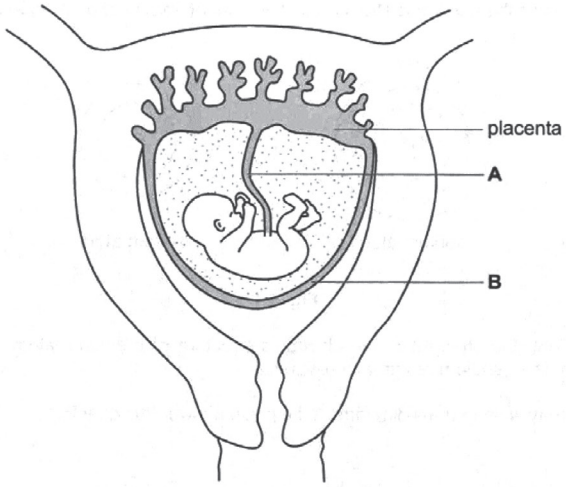


Fig. 4.2

(i) Name structures **A** and **B** shown in Fig. 4.2.

A umbilical cord

B amniotic sac

4

[2]

(ii) The placenta is the organ where exchange of materials between mother and child occurs.

Underline **two** words or phrases from the list to show substances that have a net movement **from mother to baby** through the placenta.

amino acids bone carbon dioxide cellulose glucose

glycogen white blood cells

5

[2]

[Total: 8]

4 Both marks are awarded. The slight mis-spelling of umbilical is acceptably close to the mark scheme answer.

Mark for (c)(i) = 2 out of 2

5 Both of the underlined words are correct. The third underlining is clearly crossed out and so is ignored.

Mark for (c)(ii) = 2 out of 2

Total mark awarded = 5 out of 8

How the candidate could have improved their answer

- **(a)** The candidate should have stated the names of parts **A** and **B**. No credit was available for describing the functions of **A** and **B**.
- **(b)(i)** Fallopian tube was accepted as an alternative to oviduct, and a mark would have been awarded for *phelopeon tube* because this is phonetically close enough. However, the candidate should have avoided any reference to *ovule* in a question concerned with animal reproduction.
- **(c)(i)** The answer would have been improved by the correct spelling of umbilical.

Example Candidate Response – low	Examiner Comments

4 Fig. 4.1 is a diagram of a sperm cell showing its adaptive features.

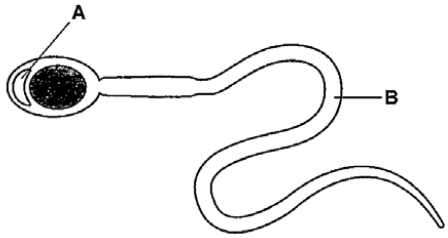


Fig. 4.1

(a) Name the adaptive features **A** and **B**.

A strong 'head' to break into egg cell.

B tail to move faster

[2]

(b) During fertilisation, the nucleus of the sperm cell fuses with the nucleus of an egg cell inside the female reproductive system.

(i) State where, inside the female reproductive system, fertilisation takes place.

Uterus [1]

(ii) Explain why additional sperm cells cannot enter the egg after fertilisation.

Once the egg is fertilised no more sperm cells can go in. [1]

1 Label A points to one of the adaptive features of the sperm cell that is stated in the syllabus. The answer head is not sufficiently detailed and so no mark is awarded.

2 The other adaptive feature of the sperm cell referred to in the syllabus is flagellum. The answer *tail* is not precise enough and so no mark is awarded.

Mark for (a) = 0 out of 2

3 This answer is incorrect.

Mark for (b)(i) = 0 out of 1

4 This answer simply repeats the information in the question. There is no relevant additional information and so no mark is awarded.

Mark for (b)(ii) = 0 out of 1

Example Candidate Response – low, continued	Examiner Comments

(c) Fig. 4.2 shows a diagram of a uterus containing a fetus.

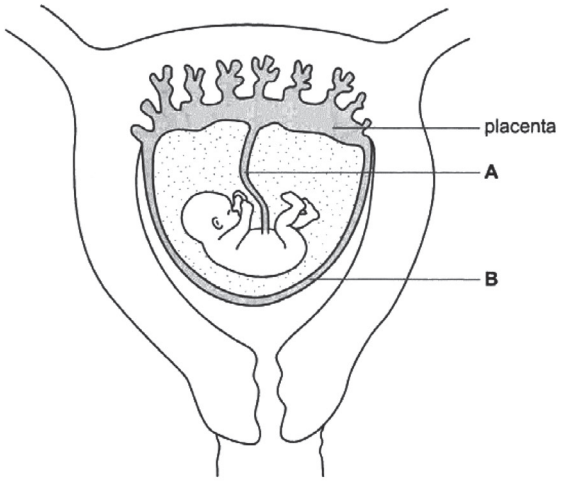


Fig. 4.2

(i) Name structures **A** and **B** shown in Fig. 4.2.

A Umbilical chord

B liquid bag to stop hits and protect the baby. 5

[2]

(ii) The placenta is the organ where exchange of materials between mother and child occurs.

Underline **two** words or phrases from the list to show substances that have a net movement **from mother to baby** through the placenta.

amino acids **bone** **carbon dioxide** **cellulose** **glucose**

glycogen **white blood cells** 6

[2]

[Total: 8]

5 The answer for **A** is correct. The answer for **B** correctly describes the function of the amnion and amniotic fluid but because **B** is named incorrectly no mark is awarded.

Mark for (c)(i) = 1 out of 2

6 This is the correct answer.

Mark for (c)(ii) = 2 out of 2

Total mark awarded = 3 out of 8

How the candidate could have improved their answer

- **(a)** The candidate should have stated the adaptive features, *enzymes* and *flagellum*, stated in the syllabus and in the mark scheme. The terms *head* and *tail* were not precise enough to allow any credit.
- **(b)(i)** The candidate should have stated *oviduct* and not *uterus*.
- **(b)(ii)** The candidate should have done more than repeat the information in the question. They needed to refer to the change in jelly coating which occurred once the first sperm has entered the egg.
- **(c)(i)** Although the function of the amniotic sac and amniotic fluid were described correctly, the term *liquid* bag was not sufficiently accurate to allow any credit.

Common mistakes candidates made in this question

- There were two main types of mistake that candidates made in **(a)**. The most common was to state the two features as **A** *head* and **B** *tail*, neither of which were listed in the syllabus as adaptive features of the sperm cell. Candidates should have noticed that the labelling line for **A** clearly points to a specific feature inside the cell. The second main type of mistake was to describe, often very well, the functions of features A and **B** without stating their names as the question asked.
- **(b)(i)** Many of the parts of the female reproductive system were suggested. The most popular incorrect answers were ovary and uterus.
- **(b)(ii)** Candidates often did no more than repeat the information in the question with answers such as *When one sperm has gone into the egg it stops any more from entering* or *Once a sperm has entered the egg closes up*. Answers that referred to the formation of a barrier needed to avoid the suggestions that the egg forms a *shell* or a *wall* or that some kind of membrane is formed.
- **(c)(i)** Most mistakes were made when attempting to name structure **B**. Common mistakes included uterus and placenta. The words umbilical and amniotic were often mis-spelt but marks were awarded if candidates' attempts were obviously close.
- **(c)(ii)** The two most common distractors were carbon dioxide and glycogen.

Question 5

Example Candidate Response – high

5 (a) Sodium burns in oxygen to produce sodium oxide, an ionic compound.

Fig. 5.1 shows the electronic structure of a sodium atom and of an oxygen atom.

sodium atom oxygen atom

Fig. 5.1

(i) Describe the changes in the electronic structure of a sodium atom and of an oxygen atom when sodium reacts with oxygen.

You may wish to draw diagrams to help you answer this question.

Two
A sodium atoms loses one (1) electron each to the oxygen atom. Then both atoms become ions because they have a full outer shell of electrons. The oxygen atoms gain an electron from each sodium atom & bond ionically [2]

(ii) Predict the chemical formula of sodium oxide.

Explain your answer.

chemical formula Na_2O (2)

explanation two sodium atoms are needed to satisfy one oxygen with a full outer shell. Sodium = group 1 Oxygen = group 6 [2]

Examiner Comments

1 The candidate makes it clear that a sodium atom loses one electron, and that an oxygen atom gains a total of two electrons. Both marks are awarded.

Mark for (a)(i) = 2 out of 2

2 The chemical formula is correct. The explanation is not clear and contains no direct reference to numbers of electrons or to the balance of ionic charges. One mark only is awarded.

Mark for (a)(ii) = 1 out of 2

Example Candidate Response – high, continued

(b) Fig. 5.2 shows part of the structure of a sodium chloride crystal.

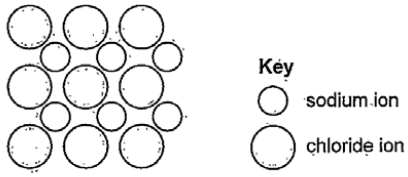


Fig. 5.2

Explain how ionic bonding keeps sodium ions and chloride ions together.

3

The ions are different sizes so when they give or lose an electron they are bonded closely and they cannot slide past or over each other, lattice structure [1]

(c) Sodium chloride is made by reacting aqueous sodium hydroxide with dilute hydrochloric acid.

Construct the symbol equation for this reaction.

Include state symbols.

4

$HCl(aq) + NaOH(aq) \longrightarrow NaCl(aq) + H_2O(l)$ [2]

(d) Lithium, sodium, potassium and rubidium are Group I elements in the Periodic Table, shown on page 24.

Table 5.1 shows the melting points of some of these Group I elements.

Table 5.1

Group I element	melting point/°C
lithium	181
sodium	98
potassium	64
rubidium	39

5

Rubidium is a solid at 20 °C.

(i) Complete Table 5.1 by suggesting the melting point of rubidium. [1]

(ii) Explain your answer to **(d)(i)**.

As you go down group I the melting point decreases

6

[1]

(iii) Explain why these Group I metals cannot be extracted from their ores by heating the ores with carbon.

Because they are all more reactive than carbon

7

[1]

[Total: 10]

Examiner Comments

3 This answer contains no information about opposite electrical charges on the ions or the attractive force between them. No mark is awarded.

Mark for (b) = 0 out of 1

4 This is a very good answer and both marks are awarded.

Mark for (c) = 2 out of 2

5 This estimate of the melting point is within the allowed range of 25°C to 55°C inclusive.

Mark for (d)(i) = 1 out of 1

6 This answer is correct.

Mark for (d)(ii) = 1 out of 1

7 This answer is correct.

Mark for (d)(iii) = 1 out of 1

Total mark awarded = 8 out of 10

How the candidate could have improved their answer

- **(a)(ii)** The candidate should have described how the total positive charge of two sodium ions balanced the total negative charge on one oxide ion. The wording *two sodium atoms are needed to satisfy one oxygen atom* essentially repeats the information summarised in the chemical formula and the remainder of the answer was too vague.
- **(b)** The candidate should have described the strong attractive force between ions of opposite electrical charge.

Example Candidate Response – middle	Examiner Comments

5 (a) Sodium burns in oxygen to produce sodium oxide, an ionic compound.

Fig. 5.1 shows the electronic structure of a sodium atom and of an oxygen atom.

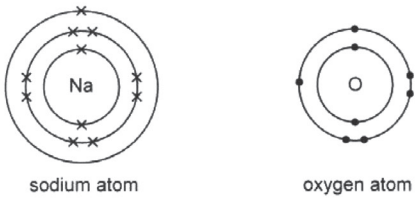


Fig. 5.1

(i) Describe the changes in the electronic structure of a sodium atom and of an oxygen atom when sodium reacts with oxygen.

You may wish to draw diagrams to help you answer this question.

Two sodium atoms react with one atom of oxygen, and each sodium atom gives one electron each to the oxygen atom (1)

[2]

(ii) Predict the chemical formula of sodium oxide.

Explain your answer.

chemical formula Na_2O (2)

explanation Because oxygen wants to gain 2 electrons and Sodium wants to lose 1 electron so whe two sodium react with one oxygen they balance out [2]

(1) The candidate makes it clear that a sodium atom loses one electron, and that an oxygen atom gains a total of two electrons. Both marks are awarded.

Mark for (a)(i) = 2 out of 2

(2) The chemical formula is correct. The explanation implies the balancing of charge as stated on the mark scheme. Both marks are awarded.

Mark for (a)(ii) = 2 out of 2

Example Candidate Response – middle, continued

(b) Fig. 5.2 shows part of the structure of a sodium chloride crystal.

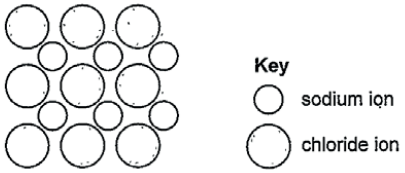


Fig. 5.2

Explain how ionic bonding keeps sodium ions and chloride ions together.

Because sodium ions drives to remove an electrons and chloride ions drive to gain on so when the react they stay together [1]

3

(c) Sodium chloride is made by reacting aqueous sodium hydroxide with dilute hydrochloric acid.

Construct the symbol equation for this reaction.

Include state symbols.

$NaHO_{(aq)} + HCl_{(l)} \rightarrow NaCl_{(l)} + H_{2(g)}$ [2]

4

(d) Lithium, sodium, potassium and rubidium are Group I elements in the Periodic Table, shown on page 24.

Table 5.1 shows the melting points of some of these Group I elements.

Table 5.1

Group I element	melting point/°C
lithium	181
sodium	98
potassium	64
rubidium	96

5

Rubidium is a solid at 20 °C.

(i) Complete Table 5.1 by suggesting the melting point of rubidium. [1]

(ii) Explain your answer to **(d)(i)**.

In Group one elements as we go down melting point dereases and Rubidium is solid at 20° so it's melting point is higher than 20° and lower than potassiums [1]

6

(iii) Explain why these Group I metals cannot be extracted from their ores by heating the ores with carbon.

Because Grap I metals want to lose one electron but carbon want to gain or ~~to~~ lose four [1]

7

[Total: 10]

Examiner Comments

3 The candidate does not refer to the attractive force between oppositely charged ions. No mark is awarded.

Mark for (b) = 0 out of 1

4 The equation contains one incorrect substance and so no mark is awarded. The mark for correct balancing is only awarded if all of the substances are correct.

Mark for (c) = 0 out of 2

5 This estimate of the melting point is within the allowed range of 25°C to 55°C inclusive.

Mark for (d)(i) = 1 out of 1

6 This is a very good answer.

Mark for (d)(ii) = 1 out of 1

7 This answer contains correct factual information but this is not relevant. No mark is awarded.

Mark for (d)(iii) = 0 out of 1

Total mark awarded = 6 out of 10

How the candidate could have improved their answer

- **(a)(ii)** This answer would have been improved if the candidate had described how the total positive charge of two sodium ions balanced the total negative charge on one oxide ion.
- **(b)** The candidate should have described the strong attractive force between ions of opposite electrical charge.
- **(c)** The equation should have included the formula for water, H_2O, as one of the products. Although the equation was logically balanced, no credit was awarded for this if any of the chemical formulae were incorrect. Similarly, no credit was awarded for state symbols associated with incorrect chemical formulae.
- **(d)(iii)** The candidate should have compared the reactivity of Group 1 metals with that of carbon.

Example Candidate Response – low

5 (a) Sodium burns in oxygen to produce sodium oxide, an ionic compound.

Fig. 5.1 shows the electronic structure of a sodium atom and of an oxygen atom.

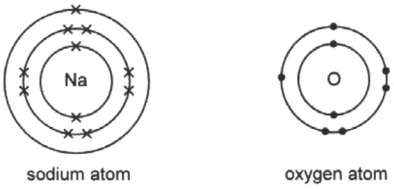
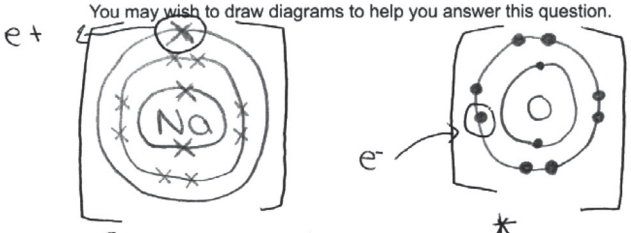


Fig. 5.1

(i) Describe the changes in the electronic structure of a sodium atom and of an oxygen atom when sodium reacts with oxygen.

You may wish to draw diagrams to help you answer this question.



1

Sodium needs to lose * an electron so thats its outer shell is full and oxygen needs to gain an electron ** so it's outer shell is ful [2]
* and gives it to the oxygen

** from the sodium atom

(ii) Predict the chemical formula of sodium oxide.

Explain your answer.

chemical formula $Na^{+}O_{2}^{-}$

explanation oxygen always comes in pairs so there needs to be 2 [2]

2

Examiner Comments

1 The candidate states clearly using words and a diagram that a sodium atom loses one electron. They state incorrectly that an oxygen atom gains only one electron. One mark is awarded.

Mark for (a)(i) = 1 out of 2

2 Both the chemical formula and the explanation are incorrect.

Mark for (a)(ii) = 0 out of 2

Example Candidate Response – low, continued

(b) Fig. 5.2 shows part of the structure of a sodium chloride crystal.

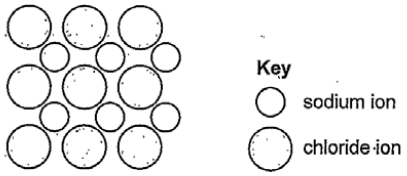


Fig. 5.2

Explain how ionic bonding keeps sodium ions and chloride ions together.

They now share electrons so they are harder to split apart. 3 [1]

(c) Sodium chloride is made by reacting aqueous sodium hydroxide with dilute hydrochloric acid.

Construct the symbol equation for this reaction.

Include state symbols.

$NaH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(l)}$ 4 [2]

(d) Lithium, sodium, potassium and rubidium are Group I elements in the Periodic Table, shown on page 24.

Table 5.1 shows the melting points of some of these Group I elements.

Table 5.1

Group I element	melting point/°C
lithium	181
sodium	98
potassium	64
rubidium	52

5

Rubidium is a solid at 20 °C.

(i) Complete Table 5.1 by suggesting the melting point of rubidium. [1]

(ii) Explain your answer to **(d)(i)**.

it is lower down the group so the melting point is lower. 6 [1]

(iii) Explain why these Group I metals cannot be extracted from their ores by heating the ores with carbon.

They are more reactive than carbon so will just form bonds with the carbon. 7 [1]

[Total: 10]

Examiner Comments

3 The candidate does not refer to the attractive force between oppositely charged ions. No mark is awarded.

Mark for (b) = 0 out of 1

4 The chemical equation is incorrect.

Mark for (c) = 0 out of 2

5 This estimate of the melting point is within the allowed range of 25°C to 55°C inclusive.

Mark for (d)(i) = 1 out of 1

6 The melting point trend in Group 1 is implied clearly enough in this answer. One mark is awarded.

Mark for (d)(ii) = 1 out of 1

7 In this case, the word **They** is assumed to refer to Group 1 metals because of the way the question is worded. One mark is awarded. In general, answers should be specific and avoid general terms such as 'they' and 'it'.

Mark for (d)(iii) = 1 out of 1

Total mark awarded = 4 out of 10

How the candidate could have improved their answer

- **(a)(i)** The candidate would have been awarded the second mark if they had made it clear that each oxygen atom gains two electrons.
- **(a)(ii)** The chemical formula should not have included electrical charges and the subscript $_2$ should have been positioned correctly. The candidate should have explained that the total positive charge of two sodium ions was required to balance the total negative charge on one oxide ion.
- **(b)** The candidate should have described the strong attractive force between ions of opposite electrical charge.
- **(c)** The candidate needed to include correct chemical formulae for all of the reactants and all of the products. The subsequent mark for balancing and state symbols depended on a full set of correct formulae.
- **(d)(iii)** This answer would have been better if the candidate had started their answer with *Group 1 metals are...* rather than *They are*. The first line gave the required answer. The remainder of the answer did not contradict the first line and so in this case, was ignored.

Common mistakes candidates made in this question

- **(a)(i)** A common mistake was to suggest that each oxygen atom gained one electron rather than two. The other main type of mistake was to describe the formation of covalent bonds between the two elements.
- **(a)(ii)** The most common incorrect formulae for sodium oxide were NaO_2 and NaO. Where the correct formula had been given, a detailed explanation in terms of the balance of ionic charge was frequently missing. Candidates made vague suggestions, for example, It is *Na_2O because of the swap and drop rule* or *Because sodium is in Group 1 and oxygen is in Group 6*. Answers like these were not awarded credit.
- **(b)** The idea that ionic bonds emerge from the attractive force between ions of opposite electrical charge was frequently missed. Candidates very often repeated some or all of their answers to part **(a)** but did not refer to ionic charge in a way that credit could be awarded.
- **(c)** Many of the candidates who stated all of the correct chemical formulae gave incorrect state symbols. The most common mistakes involved using the symbols for an aqueous solution (aq) and a liquid, (*l*) incorrectly. Another common mistake was to assign the state symbol (s) to sodium chloride. The mark for correct balancing and state symbols depended on all of the chemical formulae being correct and so, any mistake in any of the chemical formulae meant that no mark was awarded.
- **(d)(ii)** When candidates described the decrease in melting point *down the table* they needed to make it very clear that they were referring to the Periodic Table and not Table 5.1 in the question. Another reason credit was not awarded was that candidates stated that the melting point had to be between 20°C and 64°C, which is correct. However, this answer did not explain why this was the case and so no mark could be awarded. Another mistake was to suggest a connection between melting point and chemical reactivity rather than position of the element within Group 1.
- **(d)(iii)** It was common for candidates to state simply that *Group 1 metals are very reactive*. No mark could be awarded unless the comparison was made with the reactivity of carbon. Other mistakes included the idea that Group 1 metals would not react with carbon and that Group 1 metals are less reactive than carbon.

Question 6

Example Candidate Response – high

6 Fig. 6.1 shows an electrical device used in kitchens to kill insects. Insects can spread disease by contaminating food.

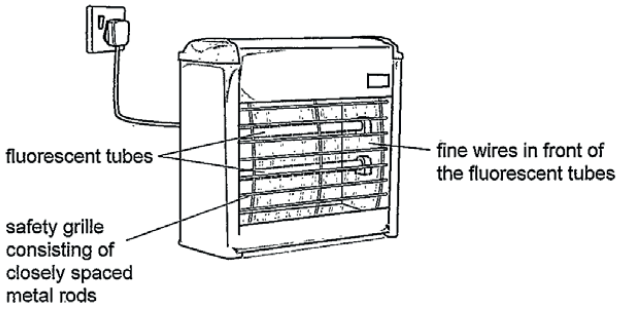


Fig. 6.1

The device is connected to the electricity supply.

(a) Fig. 6.1 shows several fine wires in front of the two fluorescent tubes. The insects have to fly between the wires as they go towards the light.

A potential difference of 2000 V exists between each pair of wires.

When an insect touches two wires at once, it completes an electric circuit.

A current of 0.50 A flows through the insect for 0.10 s.

(i) Calculate the energy transferred to the insect.

Show your working.

$P = IV = 1000\ W$

$P = \frac{E}{t}$ 1

$1000 = \frac{E}{0.10}$ $E = 1000 \times 0.10$

energy = 100 J [2]

(ii) Calculate the total electric charge that passes through the insect.

Show your working and give the unit of your answer.

$Q = It = 0.50 \times 0.10 =$

2

charge = 0.05 unit coloumbs [3]

Examiner Comments

1 Detailed working is shown and the correct numerical answer is calculated. Two marks awarded.

Mark for (a)(i) = 2 out of 2

2 Detailed working is shown and both the numerical answer and its unit are correct. Three marks awarded.

Mark for (a)(ii) = 3 out of 3

Example Candidate Response – high, continued	Examiner Comments
(b) The fluorescent tubes emit ultraviolet radiation that can be seen by many insects. This attracts them to the device. The wavelength of the ultraviolet radiation is 184×10^{-9} m. The speed of electromagnetic radiation is 3.0×10^{8} m/s. Calculate the frequency of the ultraviolet radiation emitted. Show your working. $v = f\lambda$ $f = \frac{v}{\lambda} = \frac{3 \times 10^{8}}{184 \times 10^{-9}} =$ 3 frequency = 0.0016 Hz [2] (c) Suggest why a grille of metal rods is placed across the front of the device. So that a person cannot touch the hot tubes or wires [1] 4 [Total: 8]	3 All of the working is correct but the final answer is incorrect. One mark is awarded. Mark for (b) = 1 out of 2 4 This answer is one of many acceptable ways of expressing the idea shown in the mark scheme. Mark for (c)(i) = 1 out of 1 **Total mark awarded = 7 out of 8**

How the candidate could have improved their answer

(b) The candidate should have calculated the exponent correctly.

Example Candidate Response – middle

6 Fig. 6.1 shows an electrical device used in kitchens to kill insects. Insects can spread disease by contaminating food.

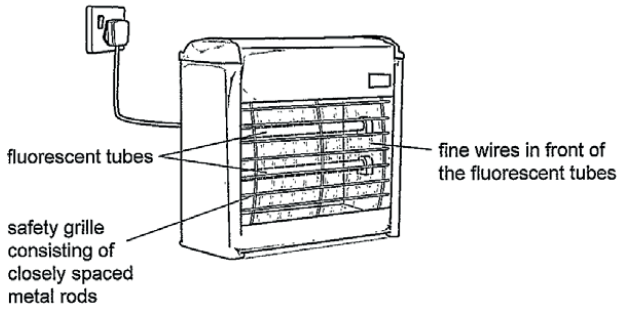


Fig. 6.1

The device is connected to the electricity supply.

(a) Fig. 6.1 shows several fine wires in front of the two fluorescent tubes. The insects have to fly between the wires as they go towards the light.

A potential difference of 2000 V exists between each pair of wires.

When an insect touches two wires at once, it completes an electric circuit.

A current of 0.50 A flows through the insect for 0.10 s.

(i) Calculate the energy transferred to the insect.

Show your working.

Energy = voltage × current × time
E = 0.50 × 2000 × 0.10

energy = 100 J [2]

(ii) Calculate the total electric charge that passes through the insect.

Show your working and give the unit of your answer.

Charge = current × speed
C = 0.50 × 0.10

charge = 0.05 unit Ω [3]

Examiner Comments

1 Detailed working is shown and the correct numerical answer is calculated. Two marks awarded.

Mark for (a)(i) = 2 out of 2

2 Detailed working is shown and the correct numerical answer is calculated. The unit is incorrect and so only two marks are awarded.

Mark for (a)(ii) = 2 out of 3

Example Candidate Response – middle, continued	Examiner Comments
(b) The fluorescent tubes emit ultraviolet radiation that can be seen by many insects. This attracts them to the device. The wavelength of the ultraviolet radiation is 184×10^{-9} m. The speed of electromagnetic radiation is 3.0×10^{8} m/s. Calculate the frequency of the ultraviolet radiation emitted. Show your working. Frequency = Speed / wavelength F = 184 x 10-9 / 3.0 x 10 8 frequency = .6.13333333333 x 10 -16 Hz [2] **(c)** Suggest why a grille of metal rods is placed across the front of the device. so only insects can fit through and it protects anything larger from touching it. [1] [Total: 8]	3 The correct relationship between wave speed, frequency and wavelength is shown and one mark is awarded for this. No mark is awarded for the final answer which is calculated from an incorrect step in the working. Mark for (b) = 1 out of 2 4 The wording in this answer is too vague. It does not specify protection of humans and refers to *it* rather than the live electrical wires. No mark is awarded. Mark for (c) = 0 out of 1 **Total mark awarded = 5 out of 8**

How the candidate could have improved their answer

- **(a)(ii)** The candidate should have stated the units as coulombs.
- **(b)** The candidate should have substituted values into the equation correctly. The final answer was the correct evaluation of the incorrect second step, but no mark could be awarded for this.
- **(c)** This answer would have been improved if the candidate had made it clear that the grille was present to prevent humans from touching the live high-voltage wires. The phrase *protects anything larger from touching it* was not precise enough.

Example Candidate Response – low

6 Fig. 6.1 shows an electrical device used in kitchens to kill insects. Insects can spread disease by contaminating food.

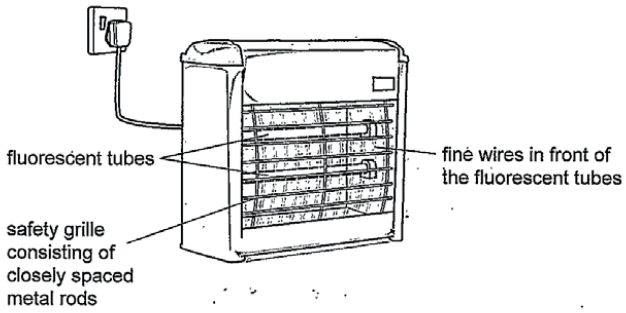


Fig. 6.1

The device is connected to the electricity supply.

(a) Fig. 6.1 shows several fine wires in front of the two fluorescent tubes. The insects have to fly between the wires as they go towards the light.

A potential difference of 2000 V exists between each pair of wires.

When an insect touches two wires at once, it completes an electric circuit.

A current of 0.50 A flows through the insect for 0.10 s.

(i) Calculate the energy transferred to the insect.

Show your working.

E = p x t

E = I x V x t

E = 0.50 x 0.10 x 2000

1

energy = ... 100 ..... J [2]

(ii) Calculate the total electric charge that passes through the insect.

Show your working and give the unit of your answer.

Q = current

2

charge = ... 5 ..... unit ..... [3]

Examiner Comments

1 Detailed working is shown and the correct numerical answer is calculated. Two marks awarded.

Mark for (a)(i) = 2 out of 2

2 The numerical answer is incorrect and no unit is given. No mark is awarded.

Mark for (a)(ii) = 0 out of 3

Example Candidate Response – low, continued	Examiner Comments
(b) The fluorescent tubes emit ultraviolet radiation that can be seen by many insects. This attracts them to the device. The wavelength of the ultraviolet radiation is 184×10^{-9} m. The speed of electromagnetic radiation is 3.0×10^{8} m/s. Calculate the frequency of the ultraviolet radiation emitted. Show your working. frequency = wavelength / ~~time~~ distance $f = \frac{184 \times 10^{-9}}{3 \times 10^{8}}$ frequency = 6.13 x 10 $^{-16}$ Hz [2] (c) Suggest why a grille of metal rods is placed across the front of the device. as a safety precaution, so you don't get an electric shock [1] [Total: 8]	3 The formula, working and final answer are incorrect. No mark is awarded. Mark for (b) = 0 out of 2 4 The reference to protecting 'you', a human, from electric shock is an acceptable way of expressing the idea shown in the mark scheme. One mark awarded. Mark for (c) = 1 out of 1 **Total mark awarded = 3 out of 8**

How the candidate could have improved their answer

- **(a)(ii)** At least one mark would have been awarded if the candidate had stated either the relationship between electric charge, current and time or given the units as coulombs.
- **(b)** It was likely that if the candidate had started this calculation using the correct formula then they would have been awarded both marks. The final answer was the correct evaluation of the previous step, but no mark could be awarded for this.

Common mistakes candidates made in this question

- **(a)(i)** Candidates who were not familiar with the correct formula tended to guess how to use the data. Common mistakes included evaluating 2000 V ÷ 0.50 A and 0.50 A ÷ 0.10 s, although many variations were seen.
- **(a)(ii)** The most common mistake made by candidates who were familiar with the correct formula was to state the incorrect unit usually either joules or watts. Mistakes in recalling the formula included suggesting charge = voltage × current although other variations were often seen. Some candidates misread 0.10 s and used 10 s in their calculation.
- **(b)** Some candidates who stated the correct formula then inverted the data when substituting and evaluated wavelength ÷ wave speed. The most common incorrect variation of the formula was frequency = wavelength × wave speed. Another type of mistake was the incorrect expression of the exponent, for example 1.63^{15}.
- **(c)** There were two kinds of common mistake. The first was to use words that lacked precision even although the candidates may have known the question was about safety. For example, *so no one can touch it or so that only bugs get killed or nothing larger than a fly can enter it*. The second type of mistake was made by candidates who had not realised that the question concerned safety and so gave answers such as *because the metal grille is a good conductor of electricity*.

Question 7

Example Candidate Response – high

7 (a) A balanced diet for a person contains all nutrients in the correct amounts for their needs.

Iron is needed in the diet. If a person does not take in enough iron they suffer from anaemia.

(i) State the name of the substance made in the body using iron.

haemoglobin 1 [1]

(ii) Explain why a person suffering from anaemia may feel tired.

Anaemia is caused due to lack of iron. There would be not enough haemoglobin in the blood to carry oxygen 2 throughout the body as haemoglobin is made using iron. So, a person may feel tired due to lack of oxygen and energy [2]

(b) A person eats the meal shown in Fig. 7.1.

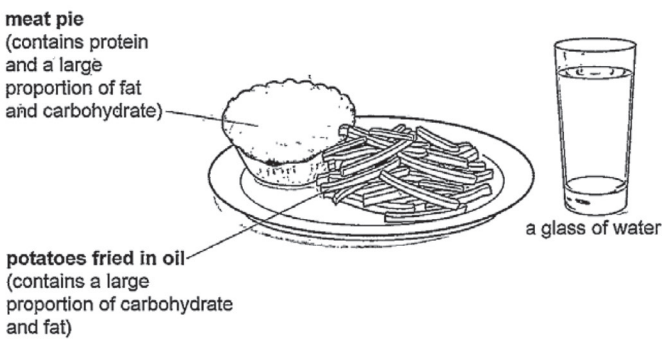


Fig. 7.1

(i) Suggest **one** food that can be added to the meal to make it more balanced.

Explain your answer.

food Salad Vegetable salad. 3

explanation Salad contains vegetables which have vitamins and fibres in them to make the meal for balanced. [2]

Examiner Comments

1 This is the correct answer.

Mark for (a)(i) = 1 out of 1

2 Two of the important points shown in the mark scheme, insufficient haemoglobin and shortage of oxygen, are stated and so two marks are awarded.

Mark for (a)(ii) = 2 out of 2

3 Both the food suggested and the explanation given match the mark scheme and so two marks are awarded.

Mark for (b)(i) = 2 out of 2

Example Candidate Response – high, continued	Examiner Comments
(ii) Explain why regularly eating meals similar to the one shown in Fig. 7.1 can lead to obesity. Use ideas about the energy requirements of the body in your answer. This meal contains lots of ~~unsaturated~~ fats (animal fat like oil) which increases the cholestrol level in our body. Hence, regular eating of meals like this will lead to obesity. 4 [2] (c) If the person eats meals similar to the one shown in Fig. 7.1 over a long period they increase their risk of developing coronary heart disease. (i) Explain what is meant by coronary heart disease. The coronary arteries that supply glucose and oxygen to the heart get blocked ~~the~~ due to accumulation of cholestrol 5 produced ~~due to~~ because of fats in the body. This [2] ~~correct~~ is the ~~blood~~ coronary heart disease (ii) Suggest why regularly eating meals similar to the one shown in Fig. 7.1 increases the person's risk of developing coronary heart disease. This meal contains lots of unsaturate animal fats which increase cholestrol level ~~which~~ that blocks the coronary arteries. [1] 6 [Total: 10]	4 This answer makes correct statements but does not answer the question. No attempt is made to compare energy requirements and energy consumed. Mark for (b)(ii) = 0 out of 2 5 This answer refers correctly to the blockage of the coronary arteries and so both marks are awarded. Mark for (c)(i) = 2 out of 2 6 This answer refers to the meal and the statement about the unsaturated fat content is an acceptable match to the mark scheme. The additional information that repeats the answer to the previous question is unnecessary. Mark for (c)(ii) = 1 out of 1 **Total mark awarded = 8 out of 10**

How the candidate could have improved their answer

- **(a)(ii)** The candidate did not need to make the point about lack of iron.
- **(b)(ii)** The candidate needed to answer this question in terms of energy. They should have stated the ideas that when the total energy taken into the body exceeded the energy used by the body then the excess was stored as fat.
- **(c)(ii)** The candidate did not need to repeat the answer to **(c)(i)** as part of this answer.

Example Candidate Response – middle

7 (a) A balanced diet for a person contains all nutrients in the correct amounts for their needs.

Iron is needed in the diet. If a person does not take in enough iron they suffer from anaemia.

(i) State the name of the substance made in the body using iron.

blood 1 [1]

(ii) Explain why a person suffering from anaemia may feel tired. 2

their body isn't making enough or good enough blood this will slow down their entire body since the organs aren't getting enough oxygen [2]

3

(b) A person eats the meal shown in Fig. 7.1.

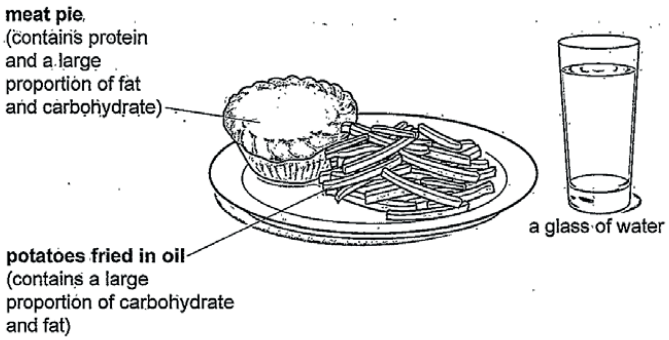


Fig. 7.1

(i) Suggest **one** food that can be added to the meal to make it more balanced.

Explain your answer.

food vegetables

explanation proteins, fats, and carbohydrates are not enough to keep the body healthy vitamins [2]

4

Examiner Comments

1 This is an incorrect answer, blood is not a single substance.

Mark for (a)(i) = 0 out of 1

2 The idea of insufficient blood is not detailed enough. No mark is awarded.

3 One mark is awarded for the idea that not enough oxygen is reaching the body.

Mark for (a)(ii) = 1 out of 2

4 This answer implies that vegetables are supplying vitamins not found in other food groups. Both marks are awarded.

Mark for (b)(i) = 2 out of 2

Example Candidate Response – middle, continued

(ii) Explain why regularly eating meals similar to the one shown in Fig. 7.1 can lead to obesity.

Use ideas about the energy requirements of the body in your answer.

Fats and carbohydrates store a lot of chemical energy (calories) too much for the body to use in a day. The body will then store the energy in fat to use another time [2]

5

(c) If the person eats meals similar to the one shown in Fig. 7.1 over a long period they increase their risk of developing coronary heart disease.

(i) Explain what is meant by coronary heart disease.

coronary heart diseas occurs when the heart isn't getting enough blood / oxygen too much of the fat, proteins this will cause the heart to stop and go into cardiac arrest [2]

6

(ii) Suggest why regularly eating meals similar to the one shown in Fig. 7.1 increases the person's risk of developing coronary heart disease.

Too much of the fats, carbohydrates and protein can damage the arteries providing the heart with blood [1]

7

[Total: 10]

Examiner Comments

5 This answer expresses the two main ideas that energy taken into the body may be more than is required, and that the excess is stored as fat. Two marks are awarded.

Mark for (b)(ii) = 2 out of 2

6 This answer contains insufficient detail. It does not mention either the coronary arteries or that CHD occurs when these are blocked.

Mark for (c)(i) = 0 out of 2

7 This answer is not awarded the mark because it refers to all of the food types in the meal and not just the fats. Although fats are stated first in the list the other food types are incorrect and cannot be ignored.

Mark for (c)(ii) = 0 out of 1

Total mark awarded = 5 out of 10

How the candidate could have improved their answer

- **(a)(i)** The candidate should have been more precise and identified haemoglobin which was the relevant substance contained in blood.
- **(a)(ii)** The first part of this answer needed to refer to a deficiency of haemoglobin rather than blood. The second part would have been better expressed in terms of oxygen supply to cells for respiration.
- **(b)(i)** This answer would have been better if the candidate had stated clearly that vegetables contain vitamins not present in other food types.
- **(c)(i)** In their answer, the candidate had to state that CHD specifically referred to the blockage of the coronary arteries. The first sentence made a relevant point but was not precise enough because oxygen and blood flow to the heart as part of the general circulatory system.
- **(c)(ii)** The answer would have been improved if the candidate had avoided adding carbohydrates and protein. These were incorrect and could not be ignored.

Example Candidate Response – low	Examiner Comments

7 (a) A balanced diet for a person contains all nutrients in the correct amounts for their needs.

Iron is needed in the diet. If a person does not take in enough iron they suffer from anaemia.

(i) State the name of the substance made in the body using iron.

Hemoglobin 1 [1]

(ii) Explain why a person suffering from anaemia may feel tired.

Because iron gives you the energy you need for the day. 2

[2]

(b) A person eats the meal shown in Fig. 7.1.

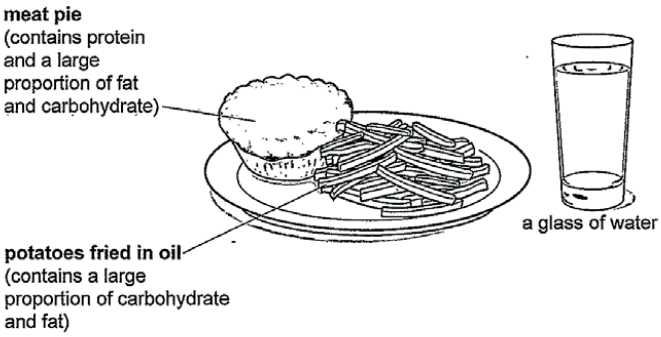


Fig. 7.1

(i) Suggest **one** food that can be added to the meal to make it more balanced.

Explain your answer.

food vegetable 3

explanation contains vitamins

[2]

1 The answer contains a spelling error but is close enough to allow the award of one mark.

Mark for (a)(i) = 1 out of 1

2 This answer is incorrect.

Mark for (a)(ii) = 0 out of 2

3 This answer matches the mark scheme and so two marks are awarded.

Mark for (b)(i) = 2 out of 2

Example Candidate Response – low, continued	Examiner Comments
(ii) Explain why regularly eating meals similar to the one shown in Fig. 7.1 can lead to obesity. Use ideas about the energy requirements of the body in your answer. Because there is a lot of fats and carbohydrate and any vitamins ~~or~~ or not enough proteins 4 ..... [2] (c) If the person eats meals similar to the one shown in Fig. 7.1 over a long period they increase their risk of developing coronary heart disease. (i) Explain what is meant by coronary heart disease. The cholesterol will increase provoating an heart attack. 5 ..... [2] (ii) Suggest why regularly eating meals similar to the one shown in Fig. 7.1 increases the person's risk of developing coronary heart disease. Because the cholesterol will increse 6 ..... [1] [Total: 10]	4 This answer does not refer to energy requirements or energy usage. No mark is awarded. Mark for (b)(ii) = 0 out of 2 5 A relevant point about cholesterol is made but none of the points shown in the mark scheme are stated. No mark is awarded. Mark for (c)(i) = 0 out of 2 6 This answer does not describe the high fat content of the meal. No mark is awarded. Mark for (c)(ii) = 0 out of 1 **Total mark awarded = 3 out of 10**

How the candidate could have improved their answer

- **(a)(i)** The answer would have been improved by the correct spelling of haemoglobin.
- **(a)(ii)** The candidate needed to state that the deficiency of haemoglobin reduced the amount of oxygen passing to cells. This then caused a decrease in the rate of respiration and therefore energy release.
- **(b)(ii)** The candidate needed to state the ideas that when the total energy taken into the body exceeded the energy used by the body then the excess was stored as fat.
- **(c)(i)** The candidate should have described CHD as the blockage of the coronary arteries. An appropriate reference to cholesterol was that it may have contributed to the build-up of deposits in the coronary arteries.
- **(c)(ii)** Instead of repeating the answer to **(c)(i)** the candidate should have described the excessive amount of fat contained in meals like the one in the question.

Common mistakes candidates made in this question

- **(a)(i)** The most common mistake was to suggest blood.
- **(a)(ii)** A frequently seen mistake was to omit any reference to haemoglobin and state that lack of iron was the direct cause of tiredness. Another mistake was to omit any reference to any deficiency and suggest simply that tiredness was caused by cells not making enough energy. Any reference to the creation of energy should have been avoided.
- **(b)(i)** A common reason why a mark was not awarded was that the explanation referred to ways in which a balanced diet was ensured rather than any reference to either fibre or vitamins.
- **(b)(ii)** There were two kinds of common mistake. One of these was the idea that excess carbohydrate and/or fat passed directly into fat cells in the body. The other mistake involved missing the instruction in the question to use ideas about energy requirements. Answers often omitted any reference to energy and contained ideas such as *eating more than is necessary and so the person becomes fat*.
- **(c)(i)** A common mistake made by candidates who were familiar with coronary heart disease was to refer to blockage of arteries or blood vessels or even veins rather than coronary arteries. Another common reason for loss of credit was to omit any reference to blood supply and to make suggestions such as *too much fat in the diet causes heart attacks*.
- **(c)(ii)** Candidates often repeated their answers to **(c)(i)** and described causes of CHD without referring to the contents of the meal in the question.

Question 8

Example Candidate Response – high

8 (a) Use the Periodic Table on page 24 to deduce the electronic structure of a calcium atom.

{2, 8, 8, 2} 1 [2]

(b) A student investigates the rate of reaction between excess dilute hydrochloric acid and powdered calcium carbonate. Carbon dioxide gas is produced in this reaction.

Fig. 8.1 shows some of the apparatus the student uses.

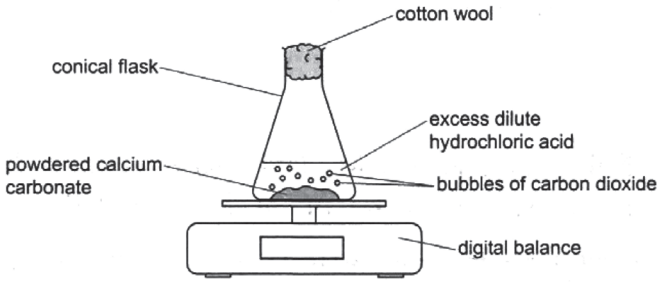


Fig. 8.1

The student measures the mass of the conical flask and its contents during the reaction.

Fig. 8.2 is a graph of the student's results.

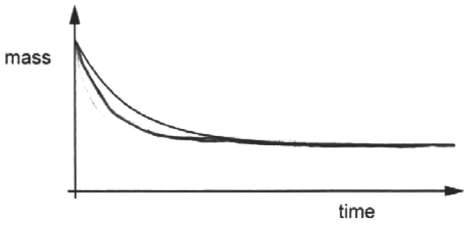


Fig. 8.2

(i) Explain why the mass of the conical flask and its contents decreases. 2

The mass decreases as the reactants get used up during the reaction to produce CO_2 which barely has any mass. [1]

Examiner Comments

1 This is an acceptable way of showing the electronic structure. The brackets are ignored.

Mark for (a) = 2 out of 2

2 This answer does not make it clear that the carbon dioxide escapes from the flask. No mark is awarded.

Mark for (b)(i) = 0 out of 1

Example Candidate Response – high, continued	Examiner Comments

(ii) Explain, in terms of particle collisions, the effect of a higher temperature on the rate of a chemical reaction.

If the temperature of a chemical reaction is increased, the particles get more energy and they start moving faster 3 with more energy. This increases the chances of collisions of particles. Hence, the rate of reaction ~~with~~ increases. [2]

(iii) The student repeats the experiment at a higher temperature.

On Fig. 8.2, sketch a line to show the results. 4 [2]

(c) Calcium chloride is produced during the reaction between calcium carbonate and dilute hydrochloric acid.

Name **one other** substance that reacts with dilute hydrochloric acid to produce calcium chloride.

Calcium Oxide [1]

5

[Total: 8]

3 This is a good answer that contains more than two acceptable points. The candidate correctly states that the rate increases because particles gain energy, move faster and so have a greater chance of colliding. Two marks awarded.

Mark for (b)(ii) = 2 out of 2

4 The line clearly shows both features stated in the mark scheme. Two marks are awarded.

Mark for (b)(iii) = 2 out of 2

5 This is one of the correct answers shown in the mark scheme.

Mark for (c) = 1 out of 1

Total mark awarded = 7 out of 8

How the candidate could have improved their answer

- **(a)** The candidate did not need to include brackets.
- **(b)(i)** The candidate should have made it clear that the gaseous product, carbon dioxide, was lost from the flask. They should also have avoided suggesting that the overall mass of reacting substances changes during a reaction.

Example Candidate Response – middle

8 **(a)** Use the Periodic Table on page 24 to deduce the electronic structure of a calcium atom.

20 1 [2]

(b) A student investigates the rate of reaction between excess dilute hydrochloric acid and powdered calcium carbonate. Carbon dioxide gas is produced in this reaction.

Fig. 8.1 shows some of the apparatus the student uses.

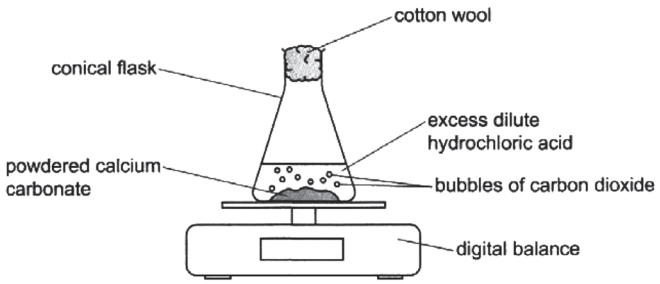


Fig. 8.1

The student measures the mass of the conical flask and its contents during the reaction.

Fig. 8.2 is a graph of the student's results.

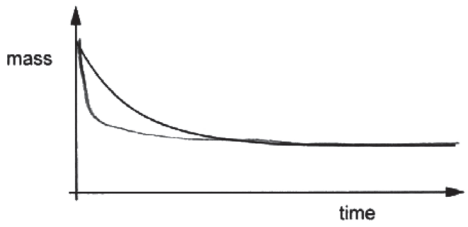


Fig. 8.2

(i) Explain why the mass of the conical flask and its contents decreases.

products are changed from solids which have a higher mass to liquids which have a lower mass. [1]

2

Examiner Comments

1 The mark is not awarded because the answer does not specify 20 electrons as stated in the mark scheme.

Mark for (a) = 0 out of 2

2 This answer does not refer to the escape of material from the flask. No mark is awarded.

Mark for (b)(i) = 0 out of 1

Example Candidate Response – middle, continued	Examiner Comments
(ii) Explain, in terms of particle collisions, the effect of a higher temperature on the rate of a chemical reaction. If the reaction is hotter the particles have more energy meaning they move more increasing the rate of sucessful collisions. 3 ..... [2] **(iii)** The student repeats the experiment at a higher temperature. On Fig. 8.2, sketch a line to show the results. 4 [2] **(c)** Calcium chloride is produced during the reaction between calcium carbonate and dilute hydrochloric acid. Name **one other** substance that reacts with dilute hydrochloric acid to produce calcium chloride. calcium oxide 5 [1] [Total: 8]	3 The candidate makes the point that particles have more energy and so is awarded the first mark. The idea of an increased rate of successful collisions is awarded the second mark. Mark for (b)(ii) = 2 out of 2 4 The line clearly shows both features stated in the mark scheme. Two marks are awarded. Mark for (b)(iii) = 2 out of 2 5 This is one of the correct answers shown in the mark scheme. Mark for (c) = 1 out of 1 **Total mark awarded = 5 out of 8**

How the candidate could have improved their answer

- **(a)** The candidate should have shown the number of electrons in each electron shell in the calcium atom. One mark would have been awarded if they had made it clear that 20 referred to the number of electrons because the Periodic Table showed that a calcium atom contains 20 protons, which means this answer was ambiguous.
- **(b)(i)** The candidate should have stated that the gaseous product, carbon dioxide, was lost from the flask.

Example Candidate Response – low

8 (a) Use the Periodic Table on page 24 to deduce the electronic structure of a calcium atom.

2,8,8,2 (1) [2]

(b) A student investigates the rate of reaction between excess dilute hydrochloric acid and powdered calcium carbonate. Carbon dioxide gas is produced in this reaction.

Fig. 8.1 shows some of the apparatus the student uses.

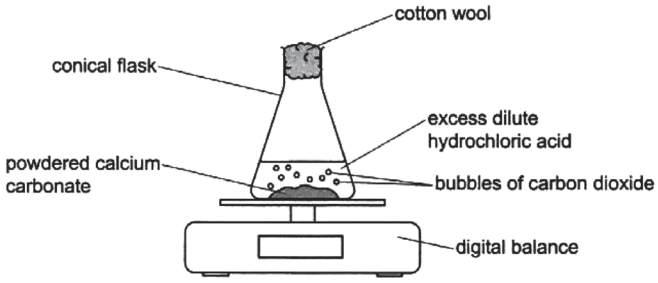


Fig. 8.1

The student measures the mass of the conical flask and its contents during the reaction.

Fig. 8.2 is a graph of the student's results.

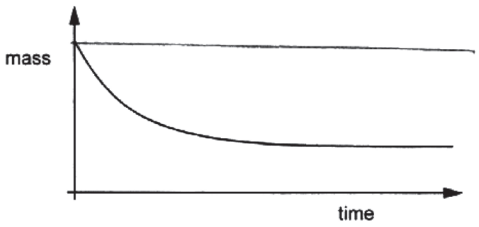


Fig. 8.2

(i) Explain why the mass of the conical flask and its contents decreases.

This happens due to the carbon dioxide produced. (2) [1]

Examiner Comments

(1) This answer is correct.

Mark for (a) = 2 out of 2

(2) This answer is incomplete in that it does not make it clear that the carbon dioxide escapes from the flask.

Mark for (b)(i) = 0 out of 1

Example Candidate Response – low, continued	Examiner Comments
(ii) Explain, in terms of particle collisions, the effect of a higher temperature on the rate of a chemical reaction. If a chemical reaction is on a higher temperature, there will be a high amount of particle collisions, this is because, the particles are more active on a high temperature. [2] (iii) The student repeats the experiment at a higher temperature. On Fig. 8.2, sketch a line to show the results. [2] (c) Calcium chloride is produced during the reaction between calcium carbonate and dilute hydrochloric acid. Name **one other** substance that reacts with dilute hydrochloric acid to produce calcium chloride. Calcium [1] [Total: 8]	3 The ideas in this answer are relevant but are lacking in precision. The suggestion that there will be a high amount of particle collisions is not the same as the idea of an increased frequency of particle collisions. The description of particles being more active is too vague. Mark for (b)(ii) = 0 out of 2 4 The line starts at the correct position but no mark is available for this. The rest of the line is incorrect and no mark is awarded. Mark for (b)(iii) = 0 out of 2 5 This is one of the correct answers shown in the mark scheme. Mark for (c) = 1 out of 1 **Total mark awarded = 3 out of 8**

How the candidate could have improved their answer

- **(b)(i)** The candidate would have been awarded the mark if they had extended the sentence to make it clear that the carbon dioxide produced escaped from the flask.
- **(b)(ii)** Instead of describing a *high amount of particle collisions* the candidate should have stated that there would be a greater number of collisions in any period of time. They needed to introduce the idea of an increased collision frequency. The suggestion that *the particles are more active* was vague and the candidate should have referred to increased particle speed.
- **(b)(iii)** The candidate needed to draw their line with an initially steeper decrease in mass but levelling out at the same mass as the given line.

Common mistakes candidates made in this question

- **(a)(i)** Candidates who were unfamiliar with electronic structures often copied information from the Periodic Table, for example, incorrect answers included *20 40*, $^{40}Ca_{20}$, *and 20*. A mark was awarded if the answer specified *20 electrons*.
- **(b)(i)** Common mistakes included suggesting that gases have no mass and that reactants lose mass when they react. The other main reason why candidates were not awarded the mark was that they did not make it clear that the carbon dioxide produced escaped from the flask. For example, the answer *because a gas is produced* was often seen but this does not specifically answer the question.
- **(b)(ii)** The usual mistake was to suggest that the reaction rate increased because *there are more collisions between particles*. Unless candidates used wording that means that the frequency of particle collisions was greater at higher temperature then the mark was not awarded.
- **(b)(iii)** The most common mistake was that candidates drew lines that levelled out at a lower mass than the given line.
- **(c)** A very large number of incorrect guesses were seen from candidates who were unfamiliar with the relevant part of the chemistry syllabus. Many of these suggestions did not contain calcium in any form. Some candidates appeared not to have read the question carefully and suggested *calcium carbonate*.

Question 9

Example Candidate Response – high	Examiner Comments

9 Fig. 9.1 shows the heating element inside an electric kettle.

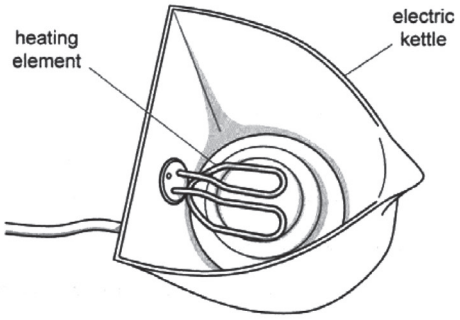


Fig. 9.1

(a) The kettle is filled with cold water at 10 °C. The heating element is turned on to boil the water.

State the temperature of the water inside the kettle when the water is boiling.

temperature = 100 °C [1]

1

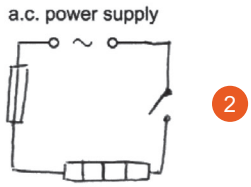
1 This is correct.

Mark for (a) = 1 out of 1

(b) The electrical circuit in the kettle contains a switch, the heating element and a fuse.

On Fig. 9.2 complete the circuit diagram for the kettle, including the symbol for a fuse.

The symbol for the heating element is:



2

2 This series circuit contains the correct symbol for a fuse and the switch is correctly shown in the open position. Two marks are awarded.

Mark for (b) = 2 out of 2

Fig. 9.2

[2]

Example Candidate Response – high, continued

Examiner Comments

(c) Fig. 9.3 shows the structure inside the tube of the heating element.

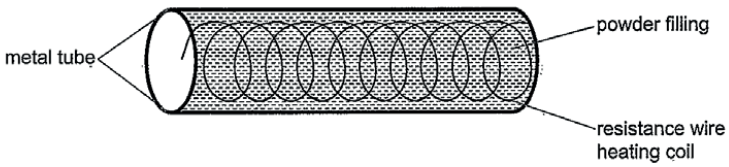


Fig. 9.3

(i) Describe in terms of molecules and other particles how thermal energy is transferred from the powder filling through the metal tube to the water in the kettle.

The ~~the~~ wire heating coil will make the neighbouring powder filling molecules vibrate and transfer heat to the metal tube by making the metal molecules vibrate. The energy of the vibrating metal molecules will be transfered to the water molecules ; which will vibrate and heat up. [2]

3 This is a good answer and contains the first and third points shown in the mark scheme. Two marks are awarded.

Mark for (c)(i) = 2 out of 2

(ii) Table 9.1 gives the properties of four substances in the form of powders.

The higher the value of the electrical conductivity of a powder, the better an electrical conductor it is.

The higher the value of the thermal conductivity of a powder, the better a thermal conductor it is.

Table 9.1

name of powder	electrical conductivity / units (low)		thermal conductivity / units (high)	
aluminium oxide	10^{-14}	2	30	3
carbon	10^{4}	4	100	1
magnesium oxide	10^{-11}	3	45	2
sulfur	10^{-15}	1	0.21	4

Use Table 9.1 to suggest the best choice of powder for the powder filling.

Give reasons for your choice.

Magnesium oxide has a good thermal conductivity and a very low electrical conductivity. Carbons electrical conductivity is too high. So Magnesium oxide would be the better choice [2]

4 This is a good answer. One of the acceptable materials is selected and the reason for the selection is a match for the ideas stated in the mark scheme. Two marks are awarded.

Mark for (c)(ii) = 2 out of 2

(iii) The resistance wire in the heating coil is replaced by a wire of the same material and length.

The new wire has a greater cross-sectional area than the original wire.

State how the resistance of the new wire compares to the resistance of the original wire.

Explain your answer.

resistance is higher

explanation due to the ~~in~~ greater cross sectional area more current is needed to pass through, therefore higher resistance [1]

[Total: 8]

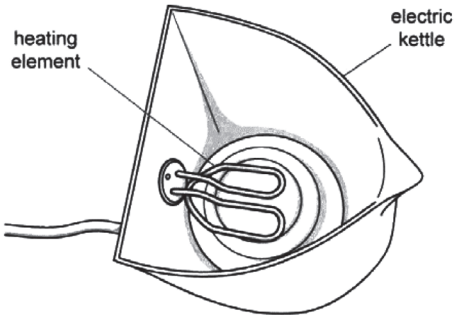
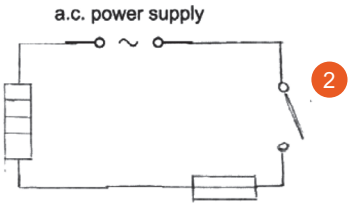
5 The explanation appears to be close to the mark scheme, but no mark is awarded because the description of the resistance is the opposite of the correct answer.

Mark for (c)(iii) = 0 out of 1

Total mark awarded = 7 out of 8

How the candidate could have improved their answer

(c)(iii) The candidate should have stated that the resistance would have been lower because of the greater cross-sectional area of the wire.

Example Candidate Response – middle	Examiner Comments
9 Fig. 9.1 shows the heating element inside an electric kettle.  **Fig. 9.1** **(a)** The kettle is filled with cold water at 10 °C. The heating element is turned on to boil the water. State the temperature of the water inside the kettle when the water is boiling. temperature = 100 1 °C [1] **(b)** The electrical circuit in the kettle contains a switch, the heating element and a fuse. On Fig. 9.2 complete the circuit diagram for the kettle, including the symbol for a fuse. The symbol for the heating element is:   **Fig. 9.2** [2]	1 This is correct. Mark for (a) = 1 out of 1 2 This series circuit contains the correct symbol for a fuse and the switch is correctly shown in the open position. Two marks are awarded. Mark for (b) = 2 out of 2

Example Candidate Response – middle, continued

(c) Fig. 9.3 shows the structure inside the tube of the heating element.

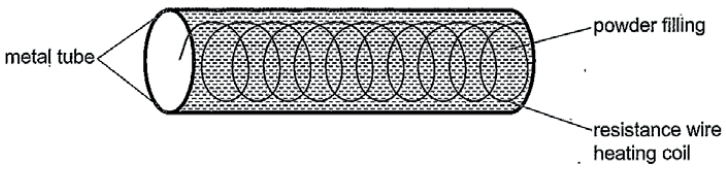


Fig. 9.3

(i) Describe in terms of molecules and other particles how thermal energy is transferred from the powder filling through the metal tube to the water in the kettle.

molecules in the powder filling transfer thermal energy by conduction by vibrations into the metal tube and the metal tube transfers the electrical energy from the power supply into thermal energy and heats the water in the kettle by convection, the hot water from the bottom rises [2]

3

(ii) Table 9.1 gives the properties of four substances in the form of powders.

The higher the value of the electrical conductivity of a powder, the better an electrical conductor it is.

The higher the value of the thermal conductivity of a powder, the better a thermal conductor it is.

Table 9.1

name of powder	electrical conductivity / units	thermal conductivity / units
aluminium oxide	10^{-14}	30
carbon	10^{4}	100
magnesium oxide	10^{-11}	45
sulfur	10^{-15}	0.21

Use Table 9.1 to suggest the best choice of powder for the powder filling.

Give reasons for your choice.

carbon powder, has the highest value of electrical conductivity so is the best electrical conductor and the highest thermal conductivity so best thermal conductor [2]

4

(iii) The resistance wire in the heating coil is replaced by a wire of the same material and length.

The new wire has a greater cross-sectional area than the original wire.

State how the resistance of the new wire compares to the resistance of the original wire.

Explain your answer.

resistance is higher

5

explanation greater cross-sectional wire takes up more space and have higher proportion against the powder filling vs. before [1]

[Total: 8]

Examiner Comments

3 This answer contains reference to thermal energy transfer by molecular vibrations through the powder and to energy transfer by convection in the water. This matches the first and fourth marking points in the mark scheme. The mistaken idea that the metal tube is connected to the power supply does not contradict the other points and so is ignored. Two marks are awarded.

Mark for (c)(i) = 2 out of 2

4 The information about carbon is correctly interpreted from the table. However, carbon is incorrect and so no mark is awarded.

Mark for (c)(ii) = 0 out of 2

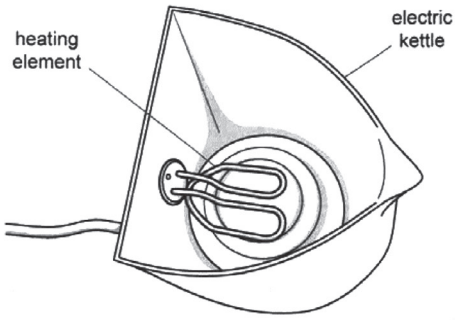
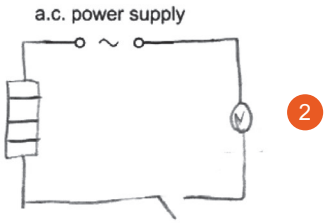
5 The description of the resistance is the opposite of the correct answer and no mark is awarded.

Mark for (c)(iii) = 0 out of 1

Total mark awarded = 5 out of 8

How the candidate could have improved their answer

- **(c)(i)** The answer would have been improved if the candidate had avoided any suggestion that an electric current passed through the metal tube.
- **(c)(ii)** The candidate should have selected either magnesium oxide or aluminium oxide and then explained that a suitable material for the powder would have a very low electrical conductivity and a reasonably high thermal conductivity.
- **(c)(iii)** The candidate should have stated that the resistance would have been lower because of the greater cross-sectional area of the wire.

Example Candidate Response – low	Examiner Comments
9 Fig. 9.1 shows the heating element inside an electric kettle.  **Fig. 9.1** **(a)** The kettle is filled with cold water at 10 °C. The heating element is turned on to boil the water. State the temperature of the water inside the kettle when the water is boiling. temperature = ...100.... 1 °C [1] **(b)** The electrical circuit in the kettle contains a switch, the heating element and a fuse. On Fig. 9.2 complete the circuit diagram for the kettle, including the symbol for a fuse. The symbol for the heating element is:   2 **Fig. 9.2** [2]	1 This is correct. Mark for (a) = 1 out of 1 2 The symbol for a fuse is incorrect but the switch is correct and the circuit is complete. One mark is awarded. Mark for (b) = 1 out of 2

Example Candidate Response – low, continued

Examiner Comments

(c) Fig. 9.3 shows the structure inside the tube of the heating element.

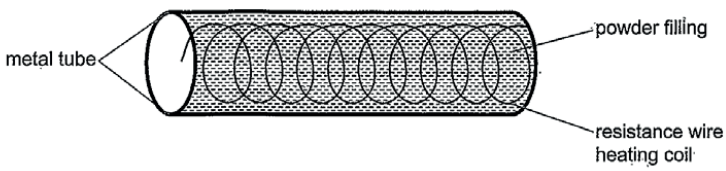


Fig. 9.3

(i) Describe in terms of molecules and other particles how thermal energy is transferred from the powder filling through the metal tube to the water in the kettle.

The powder filling is heated so particle start to move and go into the metal tube, so thermal energy is transferred

3

..... [2]

(ii) Table 9.1 gives the properties of four substances in the form of powders.

The higher the value of the electrical conductivity of a powder, the better an electrical conductor it is.

The higher the value of the thermal conductivity of a powder, the better a thermal conductor it is.

Table 9.1

name of powder	electrical conductivity / units	thermal conductivity / units
aluminium oxide	10^{-14}	30
carbon	10^{4}	100
magnesium oxide	10^{-11}	45
sulfur	10^{-15}	0.21

Use Table 9.1 to suggest the best choice of powder for the powder filling.

Give reasons for your choice.

magnesium oxides because it quite a good electrical coductor and a thermal conductor

4

..... [2]

(iii) The resistance wire in the heating coil is replaced by a wire of the same material and length.

The new wire has a greater cross-sectional area than the original wire.

State how the resistance of the new wire compares to the resistance of the original wire.

Explain your answer.

resistance is stronger

explanation because the new wire is a better conductor

5

[1]

[Total: 8]

3 This answer contains no reference to molecular vibration or any of the other points in the mark scheme. No mark is awarded.

Mark for (c)(i) = 0 out of 2

4 One mark is awarded for magnesium oxide. The suggestion that magnesium oxide is a good electrical conductor is incorrect.

Mark for (c)(ii) = 1 out of 2

5 The description of the resistance as stronger is inappropriate. No mark is awarded.

Mark for (c)(iii) = 0 out of 1

Total mark awarded = 3 out of 8

How the candidate could have improved their answer

- **(b)** The candidate would have been awarded both marks if they had drawn the correct circuit symbol for a fuse.
- **(c)(i)** The candidate could have been awarded at least one mark if they had referred to particle vibrations rather than the imprecise suggestion of particle movement. They should also have discussed how thermal energy moves beyond the tube into the water.
- **(c)(ii)** The candidate needed to interpret the electrical conductivity of magnesium oxide shown in the table as having a very low value, which would have meant that it was not a good electrical conductor.
- **(c)(iii)** The candidate should have avoided the suggestion that the resistance would have been stronger because this was not a correct description of resistance. They needed to state that the resistance would have been lower because the cross-sectional area of the wire was greater.

Common mistakes candidates made in this question

- **(b)** Many candidates were unfamiliar with the symbol for a fuse and often drew the symbol for a resistor. A variety of other incorrect symbols were suggested. The correct symbol for a switch showed it in the open position and a common mistake was to show it closed or to leave it out.
- **(c)(i)** Of those candidates who understood the context, a common mistake was to describe particle movement rather than the more precise idea of the passage of molecular vibration. One common reason why credit was not awarded was that candidates did not describe the movement of thermal energy in terms of particles as required by the question. Answers such as *heat moves through the powder by conduction* were often seen but no credit was available for this.
- **(c)(ii)** The most common mistake was to select carbon and then use the properties of carbon, correctly interpreted from the table, as the reason why carbon should be used. This suggested that these candidates did not understand the action of the heating element within the kettle.
- **(c)(iii)** Common mistakes included stating that the resistance would be higher because the cross-sectional area of the wire was greater. Another type of mistake was to use the terms, *stronger* or *weaker* to describe the resistance. Both parts of the answer had to be correct before the mark was awarded.

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